out in a smaller tunnel than the new French one. The 20 ft. tunnel in the United States and the new 24 ft. tunnel at Farnborough were, in fact, built chiefly for such work. The cost of running a full-scale tunnel, and of the preparation of machines for test therein, is necessarily heavy, and there is the limitation that even in such tunnels as those at Chalais-Meudon and Langley Field, only a small aeroplane can be tested. The limit of span, without involving large corrections for the constraint of the limited stream, would probably be about 40 ft.

In spite of such limitations—and every type of tunnel has limitations of some kind—the new equipment should prove of great value to the French in the study of aerodynamics, and it is to be hoped that results obtained by its use will be available to the world at large. It is only by careful analysis and comparison of results obtained in various types of wind tunnel and on machines in flight that the greatest use can be made of the research work of the various institutions in different countries.

Minute Intergenic Rearrangement as a Cause of Apparent 'Gene Mutation'

By H. J. Muller, A. Prokofyeva and D. Raffel, Institute of Genetics, Academy of Sciences of the U.S.S.R., Moscow

WHEN it was discovered that chromosome breakage and reattachment usually entail effects resembling those of gene mutations located at or very near the point of breakage, it was suggested, as one alternative interpretation of this phenomenon, that the change in position of genes near the breakage point, with respect to other genes in their immediate vicinity, might in itself be the cause of their altered mode of reaction upon the organism (Muller, 1930). This was an extension of the 'position effect' principle which had previously been proposed for the special case of the bar genes, two of which had been found to have a greater effect when in the same chromosome than when in opposite chromosomes (Sturtevant, 1925). Since 1930, numerous further illustrations have been found, by various investigators, showing the comparative regularity with which effects resembling those of gene mutations in nearby loci accompany breaks, but there has been little or nothing in their evidence that would serve to test the probability of the 'position effect' interpretation as opposed to the alternative conception that the disturbance involved in the process of breakage was of such a nature as to be likely simultaneously to upset and alter (once for all) the inner composition of genes in the vicinity. The senior author has now, however, obtained definitive evidence (see Muller and Prokofyeva, 1934) of the correctness of the 'position effect' interpretation, through the finding that different rearrangements involving the scute locus in *Drosophila* in the great majority of cases result in phenotypically different 'allelomorphs', whereas nearly identical rearrangements (scute 4 and scute *L*8) have given sensibly the same 'allelomorphs'.

The general question thus arises, what proportion of apparent mutations are only intergenic 'position effects' rather than autonomous intragenic changes? Of twenty-seven scute and achaete mutations investigated which have been produced by irradiation, it has so far been possible to demonstrate in eighteen cases that there was a breakage and re-attachment close to the scute or achaete locus. Some or all of the remainder also are probably intergenic rearrangements, for it has been found in this investigation that the rearrangements tend to fall into two categories, gross and minute, the latter being of such a nature that a genetic discrimination between them and true intragenic mutations would be very difficult, or in many cases even impossible.

One example of a minute rearrangement is scute 19, in which only a fraction of a single chromomere (or chromatin 'ring' number 2, as seen in the salivary gland) has, as shown both by genetic and cytological evidence (see Fig. 1), become deleted, by a break on each side of it within the same chromomere, and inserted into another region of the chromatin (within the right arm of chromosome 2). We accept here Koltzoff's explanation of the structure of the salivary gland chromosomes, as bundles of practically uncoiled chromonemata the adjacent chromomeres of which form the 'rings' or 'discs' (see also Carnoy, 1884, and Alverdes, 1912, 1913); our work, however, shows definitely that the genes—usually more than one per chromomere—are contained within these chromomeres. Special genetic and cytological methods explained elsewhere have shown that the displaced section of the chromomere here in question includes only about six (four to eight) genes. This case does not illustrate a method of origination of recognisable 'deficiencies' alone. If such a deficiency included but one or two genes, instead of six, it would in some cases be viable and resemble in its heredity an intragenic mutation, as other work of Muller (in press) has shown. On the other hand, the inserted section, without the deficiency, could be mistaken for a simple genic 'suppressor', especially since, having been weakened in its activity by the effect of its changed

position, it could appear as a recessive (unlike most recessives, however, a duplication of the region in which it lay would not serve to counteract it). These changes might or might not be detectable cytologically, depending on their size. If, finally, instead of having been lost or inserted into another region, the minute section dealt with in the case of scute 19 had only been inverted, while remaining otherwise in its place, the change would not only have behaved genetically like a gene mutation, but also it would have been impossible of recognition as a rearrangement, even by the new cytological method.

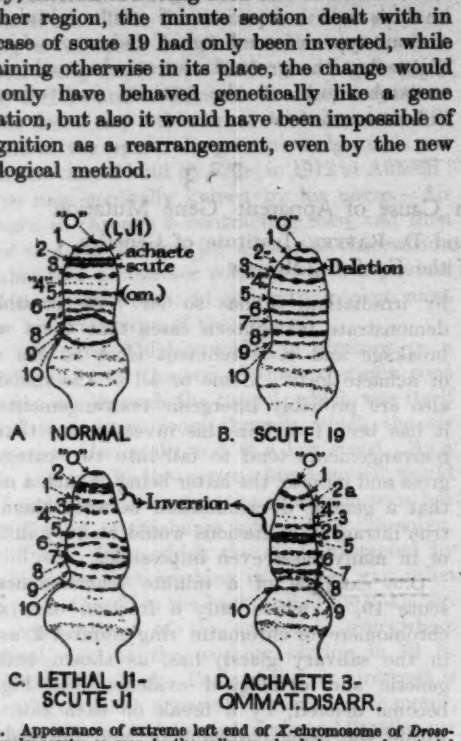

FIG. 1. Appearance of extreme left end of *X*-chromosome of *Drosophila melanogaster* as seen in the salivary gland, in normal material and in the case of three minute rearrangements. The exact or approximate () positions of the gene loci concerned are shown in the figure for the normal. All four drawings are from typical specimens and show only the terminal twentieth (±) of the entire active region of the *X*-chromosome.

The existence of minute inversions of the general type above mentioned was at first only an inference from the above and other cases of insertion, but soon actual proof of them was found. The first case in point was that of scute J1. Here cytological examination (see Fig. 1) proved that an only slightly larger section than the above, involving only two chromomeres or 'rings', 1 and 2, had become inverted (*in situ*). This was precisely the result which the senior author had been led to expect on the basis of this mutation having involved the simultaneous alteration of the effects of two nearby loci: those of lethal J1, normally to the left, as proved by genetic analysis of chromosome fragments broken between the two loci, and of scute, normally to the right. The seeming 'double mutation' here, as probably in most other cases, was simply due to the two different position effects occurring at the two different (but nearby) points of breakage and reattachment.

Another case in which the genetic expectation of a minute inversion, based on 'double mutation', was similarly confirmed by the cytological finding, was that of achaete 3 (= scute 10). Here the mutation other than that at the achaete locus was the ommatidial disarrangement 'om', which was proved to lie slightly to the right of achaete by the same method of analysis of fragments as that used before (analysis by crossing-over being virtually precluded in this as in the other two cases by reason of the small distances involved). In correspondence with this genetic situation, it was found that one point of breakage and reattachment lay within chromomere (= 'ring') 2, near the point in this chromomere where previous cytogenetic analysis by Muller and Prokofyeva (1934) had shown the achaete gene to be, while the other point of breakage and reattachment lay just to the left of or just within chromomere (= 'ring') 5, the region between these two points of breakage being exactly inverted (see Fig. 1).

Since double breaks and reattachments are not all thus accompanied by a *discernible* position effect in two demonstrably separate loci, this genetic criterion of a minute rearrangement is only sometimes provided. It is therefore evident that a minute inversion involving only a few genes (or sometimes only one gene?) would often be not only cytologically but also genetically indistinguishable from an intragenic mutation, by any methods at present in use.

C. A. Offermann has directed our attention to the fact that there is evidence from another direction that a considerable proportion (if not all) of the apparent 'gene mutations' produced by X-rays are really the effects of changes in position caused by minute intergenic rearrangements. This evidence lies in the fact that the frequency of production by X-rays of readily demonstrable (gross) gene rearrangements is vastly greater in spermatozoa than in other cells, and that, corresponding with this, the frequency of production of apparent 'gene mutations' is also considerably raised in spermatozoa, as compared with other cells—although not nearly as much raised as is the gross rearrangement frequency (see Muller and Altenburg, 1930). Now exactly such relations are to be expected, if most of the induced 'gene mutations' are fine rearrangements, and if we accept the very probable hypothesis that rearrangements, like cross-overs, require contact between two chromonemata (or two portions of one chromonema). For the chromosomes are very much more crowded together and are more condensed in spermatozoa than in other cells. The much greater degree of crowding together would

give vastly more chance for juxtaposition of parts that ordinarily lie widely separated, and so would lead to a far higher frequency of gross rearrangements, while the greater degree of condensation would give more chance for contacts on the part of the very fine loopings that would be responsible for the minute rearrangements.

As our studies of mutations in the *X* and other chromosomes have shown that apparent replicas of practically all known 'natural mutations' in *Drosophila* may also be obtained by X-rays, the further question is raised as to what proportion of 'natural mutations' in *Drosophila* may really be minute rearrangements. This question is of moment because the range of possibilities of phenotypic change through intergenic rearrangements alone must be far from adequate for any indefinitely continued evolution. The latter must depend for the most part upon intragenic change, and hence it is important for the study of evolution, though at present seemingly so impossible, to be able to distinguish some at least of the intragenic mutations from the minute intergenic types of rearrangement. The matter acquires a greater urgency for geneticists when it is realised that they may now expect to have to meet attacks from orthogeneticists and Lamarckians, who may see in the present uncertainty regarding the 'building blocks of evolution', an opportunity of reintroducing teleological notions of evolutionary causation.

In this connexion, it must not be forgotten that all the cytogenetic investigations of species-crossing have agreed in showing that species differences in general reside in chromosomal differences and are therefore fundamentally *Mendelian* in their inheritance. When the chromosomes in species-crosses are able to undergo reduction, the species differences show spread of variation and eventual return to either parent species, whereas, when chromosome segregation is prevented—whether by asexual reproduction, by division of chromosomes at both maturation divisions (as in butterfly hybrids), or by the somatic origination of allotetraploidy—the hybrids breed true. Now Mendelian differences have been found to originate only by a sudden process—mutation. Since mutations involving intergenic changes are necessarily inadequate to provide most of the material for species divergence, it logically follows that a part of the mutations must be intragenic. It is only to be expected that many of these would be similar, in their phenotypic consequences, to effects of intergenic origin, and that discrimination between the two classes of change would present considerable difficulties. Such discrimination must, however, be eventually attempted.

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Obituary

Sir Horace Lamb, F.R.S.

HORACE LAMB was born at Stockport in 1849. His childhood was passed mostly in a household where the strictness of the religious ideas prevailing at that time left little scope for his naturally happy nature and his great vitality. These qualities, which so endeared him to his friends in later years, began to appear at school. At Stockport Grammar School, he had the good fortune to come under a sound and kindly scholar named Hamilton, who quickly appreciated his merits, and finally sent him up to Cambridge, where in 1867 he gained a classical scholarship at Queens' College. At that time his allegiance was almost equally divided between classics and mathematics, but his visit to Cambridge, when he sat for the scholarship examination, turned the scale in favour of mathematics. On his return to Stockport he decided not to take up his classical scholarship but to sit for a mathematical one at Trinity in the following year. His interest in classics and literature, however, remained with him all his life, and had a profound influence on his children, all but one of whom turned to literature or art rather than to science.

The year of preparation for the mathematical scholarship was spent at Owen's College, Manchester, where, under Prof. Barker, Lamb first experienced the recondite joys of the higher mathematics. At Trinity, which he entered in 1868, he graduated as second wrangler, and was elected to a fellowship. At that time, and for some years afterwards, Cambridge mathematics was dominated by the tripos examinations. A young man's ability was judged entirely by his place in the tripos, and his competence as a mathematician by the ingenuity of the questions which he set when in due course he appeared as a tripos examiner. Among the more old-fashioned, it was considered rather pushing to publish original mathematical work. The proper way in which a lecturer could make known any theorem which he might discover in his teaching was to set it as a tripos question. The science of hydrodynamics was

at that time concerned almost entirely with an idealised, non-existent fluid which moved only in irrotational motion, without vorticity, and was thus well adapted for tripos questions.

Lamb, in his first course of lectures on hydrodynamics, given at Trinity in 1874, broke new ground when he gave an account of Helmholtz's great work on vortex motion. The substance of these lectures was published in 1878 as a "Treatise on the Motion of Fluids". This book, of some 250 pages, expanded in subsequent editions until as "Hydrodynamics" it covered some 700 pages. During its long career, which is still in full vigour, it has become the foundation on which nearly all subsequent workers in hydrodynamics have built. The long-continued supremacy of this book in a field where much development has been taking place is very remarkable, and is evidence of the complete mastery which its author retained over this subject throughout his life.

It is of interest to notice through the various editions of "Hydrodynamics" the continually increasing stress which is laid on the physical side of hydrodynamics. In the first edition (1879), the mathematical consequences of the conception of an ideal fluid are systematised and generalised in a form which is æsthetically very satisfying, and special problems are treated mostly as exercises of the type which occur in the tripos. In subsequent editions, problems are treated more from the point of view of their intrinsic interest as illustrating natural phenomena or experimental conditions. Numerical values are given for results which at first appeared only in symbolical form. Motions such as turbulent flow, which even now defy exact mathematical treatment, are discussed, in the later editions, in the partial and incomplete forms which they had attained at the time of publication. New developments have been brought into the scheme of the book, and it is this continuous growth as an organic whole that has enabled Lamb's "Hydrodynamics" to be still, after fifty-five years of life, the best book on the subject.

In 1875, Lamb married Miss Elizabeth Foot, the youngest sister of the wife of his old headmaster, and shortly afterwards he went out to Australia, where he had been appointed the first professor of mathematics and physics in the new University of Adelaide. Here he passed nine years, during which he established a laboratory and set the high tradition in science which Adelaide has preserved to this day. In spite of the cares of a large family, for three sons and three daughters were born while the Lamb family was in Australia, he published a remarkable series of papers on elastic and electric oscillations, and on hydrodynamics. These were all characterised by great clearness of expression, and they established his reputation as an applied mathematician so quickly and firmly that, at the earliest opportunity, which occurred in 1884, he was called back to England to the mathematical chair at Owen's College. At Manchester he threw himself into the work of the University and showed an aptitude for affairs which does not always accompany exceptional mathematical powers.

In his early days, Lamb was very fond of mountaineering, and he spent several seasons in the Alps. As soon as his children were old enough, he took them for long holidays walking in the Welsh hills or in Cumberland. Later he took them in turns to Italy, where he soon acquired a considerable knowledge of Italian art.

While in Manchester, Lamb spared no pains to make his lectures clear and well-ordered. The text-books which he published at that time bear witness to his care in that respect. At the same time, he made a number of important contributions to applied mathematics. The most noticeable characteristic of these works is the way in which the physical meaning of difficult analysis is clearly brought out. One of the most striking of Lamb's works published at this time is the complete analysis which he made in 1904 of the waves produced in an elastic solid by an impulse of short duration. He analysed the process by which a localised impulse can separate itself out into a number of disturbances of different types which travel at different speeds and therefore become separated. The seismological implications of this work have scarcely yet been fully discussed. Among other geophysical problems are the effect of vertical loading on the earth's surface (1917) and the waves in an atmosphere the temperature of which decreases with height (1910). This last paper must form the basis of any future attempt that may be made to calculate the tides in the atmosphere.

In 1920, Lamb retired from Manchester, and shortly afterwards returned to Cambridge, where his friend and colleague Lord Rutherford had just become the professor of physics. Trinity College made him an honorary fellow and he very frequently dined in hall, where his youthful nature made him very welcome to a company which included men nearly fifty years younger than himself.

At this time, Lamb's mind was much occupied with problems of aeronautical research. Until a few years ago, he was a member of the Aeronautical Research Committee, and when he retired from that body he still kept in touch with the more purely scientific side of its activities. Sometimes he helped with constructive criticism, sometimes he formulated aeronautical problems in a mathematical form, and sometimes he gave definite solutions of problems formulated by others. His services in this field were very much appreciated by those responsible for directing aeronautical research in Great Britain, and nowhere is his loss felt more deeply than among those whom he honoured by his kindly but telling criticism of their work.

In 1884, Lamb was elected to the Royal Society. He served three times on its Council and was twice a vice-president. In 1931, he was knighted. He was president of the British Association in 1925–26 and of its Section A in 1904. He died on December 4.

Lamb had three sons and four daughters. His eldest son, E. H. Lamb, is professor of engineering at Queen Mary College, London. The second, W. R. M. Lamb, is secretary of the Royal Academy and was formerly a fellow of Trinity. The youngest is Henry Lamb, an artist. One of his daughters is

Mrs. Palmer, now fellow and tutor of Newnham College, Cambridge. Another is Lady Brooke, wife of Sir J. R. Brooke, of the Electricity Commission.

This record of Sir Horace Lamb would be incomplete without referring to his sunny temperament and the vivid interest in every kind of human activity, which made him so fascinating a personality to all who had the good fortune to come into contact with him.

G. I. T.

Dr. A. A. Belopolsky

Aristarch Apollonovitch Belopolsky, the well-known astrophysicist, member of the Russian Academy of Sciences since 1903, honorary director of the Pulkovo Astronomical Observatory in the U.S.S.R. and since 1910 an associate of the Royal Astronomical Society in London, passed away at Pulkovo on May 16, 1934, at the age of eighty years.

The main work of Belopolsky's long and laborious life was connected with spectroscopic investigations of the sun and stars. It was he who was charged in 1891 by F. A. Bredichine, then director of the Pulkovo Observatory, with planning the astrophysical equipment for use with the 30-in. refractor, visual at first and later for photographic records. His first observations were on Nova Aurigæ, in 1892, and since he never missed any new star, he accumulated a series of valuable spectrograms and obtained in some cases pure absorption spectra characteristic of the very first stages of the outbursts. At the same time, he made spectroscopic observations of the sun and was to the last president of the Solar Committee in the U.S.S.R. He was the first to determine, in 1915, the temperature of sunspots from his spectrograms.

In 1912 the Russian Academy of Sciences placed an order with the firm of Sir Howard Grubb, then in Dublin, for a big Littrow spectrograph, of 7-metre focal distance and a dispersion in the third order of 1 mm. = 0·76 A. Owing to the War and succeeding adverse circumstances, the instrument did not reach Pulkovo until 1923, and Belopolsky immediately took up his part of the international research on the solar rotation.

Many beautiful records and classical discoveries testify to the knowledge and the experimental skill of Belopolsky. Thus, in 1894, he discovered the velocity variations of δ Cephei associated with the changes of light. Two years later he made the same discovery for η Aquilæ and in 1899 for ζ Geminorum. In 1895 he confirmed Keeler's discovery of the rotation law of the rings of Saturn. From his examination of the spectra of γ Virginis and γ Leonis he made an important advance in the determination of the parallaxes of double stars. His favourite star, however, was Polaris, and every second year he took up the determination of its elements. A very striking achievement was his experimental proof of the Doppler effect. Already in 1894 he had set up a device consisting of a series of rapidly rotating mirrors opposed to each other, thus making it possible to get very high speeds of the reflected ray of light. In 1898 the arrangement was ready and Belopolsky was able to confirm by a purely laboratory experiment a fundamental law of modern astrophysics.

To understand this remarkable gift in the application of physics to astronomy we have to go back to Belopolsky's education. His parents were well educated but poor, and they encouraged his intellectual ambitions. The boy revelled in natural sciences, made experiments at home in physics and chemistry, and was a craftsman, achieving good results with the simplest means and making instruments practically out of nothing. He studied at the University of Moscow and graduated in 1877. F. A. Bredichine was then at the head of the Moscow Observatory; he at once appreciated the gifts of the young man and made him his assistant. In 1888 Belopolsky went to the Pulkovo Observatory, where he stayed for the remainder of his life. He published his work on sunspots and their movement in 1886. From the beginning of the *Astrophysical Journal* in 1895, he took a great interest in the periodical and was one of its associate editors.

During his career at the University of Moscow, Belopolsky had to provide for himself and knew what hardship meant. But science had captured him and he never failed her, whether in good or in hard times. He was a very kind-hearted man, with a real sense of justice and truth.

Rev. T. E. Espin

We regret to record the death on December 2 of the Rev. T. H. E. C. Espin, the well-known amateur astronomer. He began observing with a 1-in. telescope while at school at Haileybury, where his interest in the heavens was aroused by the appearance of Coggia's comet in 1872, and by his form master's lectures on his favourite hobby, astronomy.

On proceeding to Oxford, where he took his degree in 1881, Espin found his first double star with a 3-in. refractor, and evinced such enthusiasm that the Savilian professor allowed him the use of the University 13-in. At the age of twenty years he was elected a fellow of the Royal Astronomical Society, and soon afterwards was appointed special observer to the Liverpool Astronomical Society, of which he was a founder and president. At West Kirby, Wallasey and Wolsingham, where he was curate (1881–88) to his father, Chancellor Espin, a well-known ecclesiastical lawyer, he astonished the astronomical world by a survey of red stars, with a large reflecting telescope, of the whole of the northern heavens; he found 3,800, a total unequalled by any other observer. During this research more than thirty variables were discovered and observed until their range and period were determined. They included several remarkable objects, notably X. Ophiuchi, V. Cassiopeiae and R. Canum Venat. At the same time he almost doubled the known number of type IV stars. In 1899 Mr. Espin began a micrometrical examination of all stars shown on Argelander's charts—a total of well over 300,000—for new double stars, and before his death had found 2,575. For these researches, extending over forty years, and for the discovery of Nova Lacertae, he received the

Jackson-Gwilt medal of the Royal Astronomical Society.

Mr. Espin invented a spectroscope, a variable-power eyepiece and Espin's star detector. On Röntgen's discovery of X-rays, he built several high tension machines, culminating in a huge 24-plate Wimshurst, with which for many years he treated invalids from all over the country. In recent years, with the collaboration of W. Milburn, his astronomical assistant, he investigated the radioactivity of local spring waters and published the results in his observatory circular for 1933.

During the later years of his life, when he was unable to spend long hours in the observatory, Espin made and examined rock sections from his specimens collected abroad, especially of those from Vesuvius, Etna and Les Puys de Dôme. His scientific interests were thus very wide, and he brought both observation and thought to bear on many objects upon the earth as well as in the heavens. There are now few natural philosophers of his type, and his death has deprived the world of one who contributed much to its knowledge.

Mr. Ernest Binfield Havell, whose death at the age of seventy-three years occurred on December 30, was well known as one of the foremost authorities on Indian art, architecture and technology. He first went to India as superintendent of the Madras School of Art, and in 1896 was transferred to the Calcutta School, retiring from the Education Service in 1908. While at Calcutta he founded what has since come to be known as the Calcutta school of painting, and it was largely owing to his interest in indigenous industries that the village hand-loom industry was revived. An intense and enthusiastic appreciation of the aims of Indian art, especially of the Mogul and Rajput schools, was the basis of his conviction that the only future possible for a living school of art in India lay in an evolutionary development of the indigenous art, free from the influence of European ideals and methods. The enthusiastic welcome and support his views received from the Nationalist party in India proved an embarrassment rather than an assistance when, after his retirement, he endeavoured to promote in England a better understanding of India's artistic achievement. Mr. Havell was a voluminous writer on Indian art and technology, his best-known work being a "Handbook of Indian Art" (1920).

We regret to announce the following deaths:

Mr. H. G. Ponting, the official photographer to the Scott Expedition of 1910–13 to the South Pole, on February 7, aged sixty-four years.

Prof. Arthur Thomson, emeritus Dr. Lee's professor of anatomy in the University of Oxford, president of the Anatomical Society of Great Britain and Ireland in 1906, on February 7, aged seventy-six years.

News and Views

Ethnographical Films

Considerable interest has been aroused by a recent announcement that the Trustees of the British Museum have accepted the donation of a cinematograph film of the life of the Worora tribe of the Kimberley district of north-west Australia. The film was presented by Mr. H. R. Balfour of Melbourne. It was taken on the Government Native Reserve of Kunmunya, and shows the present conditions of native life. Technological processes, such as the making of stone axes and spear heads, in which these people are specially skilled, the making of fire by twirling one stick on another, the spinning of human hair for thread and the like are shown as living crafts. The 'shots' also include ceremonies and dances and an emu corroboree. The film has already been shown to missionaries, learned societies and medical students in Australia; but as is explained by Sir George Hill in a letter to *The Times* of February 7, owing to the fact that it was taken on a Government reserve, under the regulations of the Commonwealth Government, it cannot be shown commercially. With the permission of the Trustees of the Museum, arrangements have been made for the film to be shown at a meeting of the Royal Anthropological Institute to be held on March 19 at the London School of Hygiene and Tropical Medicine, but only fellows of the Institute and their guests can be admitted. A description of the film has been supplied by the Rev. J. R. B. Love, who is superintendent of the reserve and is well acquainted with the language of the Worora.

Although this film will, no doubt, prove of the greatest interest as an ethnographical record, it is by no means unique. The cinematograph camera has long been used as an adjunct to ethnographical exploration. One of the earliest records of this kind was the series taken by Prof. C. G. Seligman when a member of the Cooke Daniels–Seligman expedition to New Guinea thirty years ago, which was shown at the Leicester meeting of the British Association in 1907; and the late Sir Baldwin Spencer showed a detailed record of the life and corroborees of the natives of northern Australia at a meeting of the Royal Anthropological Institute in 1914. The diffidence felt by the Trustees of the British Museum in accepting the gift, notwithstanding the fact that it was a 'non-flam' film, has directed attention to the fact that the British Museum possesses one other film only, and that there is no official collection in Britain of these extremely valuable records of the life of primitive peoples, now rapidly passing away.

The possibility of forming such a collection or repository was one of a number of points connected with the making, selection and preservation of cinematograph films of anthropological and ethnographical

interest, which was referred to a special committee appointed by the recent International Congress of Anthropological Sciences held in London in August last. The committee is international in its composition, Great Britain being represented by Capt. T. A. Joyce of the British Museum. The matter, however, is not to be allowed to rest there so far as Great Britain is concerned; and it is announced in the February issue of *Man* that the British Film Institute has established a Scientific Research Panel of its Advisory Council, of which Prof. J. L. Myres will act as chairman, to collect information as to the extent to which the cinematograph has been used in scientific work, details of methods and difficulties in technique, and particulars of films of scientific interest which have not been put into circulation through the ordinary commercial channels. The Panel will welcome information on any of these points; communications should be addressed to the Secretary, British Film Institute, 4 Great Russell Street, London, W.1.

City and Guilds (Engineering) College, London

In speaking, at the jubilee celebration of the City and Guilds (Engineering) College, Prof. H. E. Armstrong directed special attention to the origin of the Imperial College, tracing this and the general development of scientific activity at South Kensington mainly back to the late Lord Playfair, in particular to his appointment at the Museum of Practical Geology, the home of the Geological Survey, about 1843. South Kensington, he believes, is still without any memorial of the great 'little' man. Discussing the history of the Royal College of Chemistry, established in Oxford Street in 1845, now the Royal College of Science, Prof. Armstrong said that the funds were chiefly obtained from the farming community, owing to the enthusiasm aroused by Liebig in his tour throughout agricultural England in 1842–43. When the Royal College of Science was opened, its rural promoters had looked forward to the development of the school in the interests of agriculture. Man may propose but professors dispose: nothing was further from Hofmann's genius. Agricultural chemistry, Prof. Armstrong said, is not taught in England in a way in the least comparable with that in which engineering has been taught in the Guilds Colleges. He ventured to express the hope that, by the time the College of Chemistry celebrated its centenary, it will have learnt what its original purpose was and will seek to fulfil this. By that time perhaps the world will have recognised that no other subject is so worthy of chief attention as is agriculture.

Speaking of his work at the Central, after referring to the importance attached both there and at the Finsbury College to engineering as a necessary subject in the chemist's course, Prof. Armstrong said of the engineer: "I made no attempt to teach him chemistry: that I soon found to be impossible. I tried to teach him through simple acts of chemical inquiry, to experiment with a purpose; to observe accurately: above all to describe his work in lucid English: to take notes, in short, the hardest task of all. My schoolmastering was not popular with many, at the time. In after years I have had my full reward, as not a few have told me that my insistence on their learning to help themselves has been of special value to them". He ended by saying: "At this, perhaps the most critical and solemn moment of my life, in the interests of our national engineering efficiency, I would plead for the recovery of the original spirit and a reconstitution of the College as a separate entity."

Sir Alfred Ewing and Seismometry

Dr. C. Davison writes: "During the five years (1878–83) that Ewing spent in Japan, like other English teachers in Tokyo he was infected by the enthusiasm of Prof. John Milne, and became one of the first members, and afterwards a vice-president, of the Seismological Society of Japan founded by Milne in 1880. At one of the early meetings of the Society in that year, Ewing described his seismograph for horizontal motion, in which he preceded Rebeur-Paschwitz in devising a horizontal pendulum with two fixed supports. In 1881, he followed with an account of a seismometer for vertical motion, this, with the preceding, forming the well-known instrument made by the Cambridge Instrument Co., Ltd. In the following year, he devised his duplex pendulum seismometer. The horizontal pendulum was erected in the Engineering Laboratory of the University of Tokyo in November 1880, and, at several later meetings of the Seismological Society, he exhibited the diagrams obtained with it. The interest aroused by these early accurate records of the movements of the ground during an earthquake can be readily imagined. Shortly before he left Japan, Ewing wrote his great memoir on 'Earthquake Measurement', in which he described the various forms of known seismographs and their underlying principles (*Tokyo Univ. Sci. Dept. Mems.*, No. 9; 1883). Soon after this, his active interest in seismometry seems to have ceased, for, after his return to Great Britain, he made only one new contribution, that on seismometric measurements of the vibrations of the Tay Bridge during the passing of railway trains (*Roy. Soc. Proc.*, 44, 394–402; 1888). In these experiments made with a duplex pendulum seismometer, he showed that the greatest lateral and longitudinal movements of the bridge were about $\frac{1}{10}$ in. and $\frac{1}{20}$ in. respectively."

Research Laboratory at the National Gallery

Towards the end of 1934, the Trustees of the National Gallery approved a scheme for the establishment of a laboratory to undertake the physical examination of pictures by means of X-rays, ultra-violet and infra-red radiations, and by micrographic methods. They also appointed a committee, consisting of Sir Henry Lyons, Sir William Bragg, and Dr. H. J. Plenderleith, to act as an advisory body, should need arise: the laboratory is in charge of Mr. F. I. G. Rawlins. A considerable amount of the plant has already been installed, and work has begun with photomicrographic investigations, and to some extent with ultra-violet light. At the present rate of progress

it is expected that the laboratory will be fully equipped by the end of April. The X-ray apparatus will contain several novel features. In addition, a number of ancillary researches are being initiated, including the microscopical examination of woods used for panels: it is hoped that this inquiry will produce valuable data for making the description of works in future editions of the catalogue more exact, as well as being a help in the question of attribution.

Large Sunspot Group

A MODERATELY large sunspot group which formed on February 5 has attracted, for its size, an undue amount of notice in the daily Press. The group occupies about 800 millionths of the sun's hemisphere, and a spot of these dimensions will be no uncommon occurrence during the next six or seven years, as the sunspot cycle passes through its maximum in 1938. Actually, a larger group, occupying 1000 millionths of the sun's hemisphere, has already appeared since the last minimum in 1933. This group had its central meridian passage on April 21.9, 1934 (see the *Observatory* for February 1935, where an account of 1934 sunspot activities will be found). The present spot is, however, not without interest. No spot was detected on a photograph exposed at Greenwich on February 5 at 10^h, but at 11^h a spectroscopic disturbance was *seen* in the spectrohelioscope, which seems to have been the genesis of the actual spot. On account of cloud, no photoheliogram was taken on February 6, and the spot appeared fully developed on February 7. The spot's latitude is 14° S., and it was born west of the central meridian. Its central meridian passage—if it survives—will take place on March 14 next. The spot is of such a size that it could just be seen by the naked eye if it was on the central meridian. Near the limb, where the spot appears foreshortened, a spot of this size would be invisible. It is interesting to note that the number of naked eye sunspots per annum follows the ordinary sunspot curve very closely, and that the 11-year cycle could well have been discovered by an observer provided only with a smoked glass—and a good climate.

Natural and Artificial Clouds

IN his Friday evening discourse at the Royal Institution on February 8, Sir Gilbert Walker discussed natural and artificial clouds. Apart from cumulus clouds of various types, the causes of the geometrical patterns that are to be seen in the sky must be sought in the behaviour of layers of fluid which are made unstable either by heating them from below or cooling them from above. It has been known for fifteen years that a stationary liquid when unstable develops a polygonal pattern, and that an unstable liquid flowing down a trough forms pairs of vortices rotating in opposite directions, with their axes parallel to the direction of flow, or of shear. Sir Gilbert's pupils have carried these investigations further, and A. Graham used a wind tunnel formed with a heated iron plate as lower surface; its upper surface was a cool glass strip 8 ft. long and 9 in. wide, a third of an inch above the iron plate. When pulled by a motor, this gave variable rates of shear in the air. The former explanation of clouds occurring in long rolls or in a rectangular pattern as caused by Helmholtz waves was shown to be unsatisfactory; and it was verified that while a rapid shear due to motion exceeding one inch a second produces longitudinal cells, one less than a fifth of that rate leads to transverse cells, and an intermediate rate to a rectangular pattern. Various types of longitudinal clouds were discussed, and Sir Gilbert withdrew his former explanation of spirals in these clouds as due to stream lines, showing that there are normally two equidistant spirals like those in a twistdrill, and that these appear to be the two component vortices intertwined. Photographs of clouds were used to demonstrate the formation of a number of patterns of clouds at different heights; and an account was given of the explanation suggested by A. Graham of the paradox that, in the laboratory, liquid rises in the axis of a cell while in air there is descent there. Attention was also directed to the existence of clouds due to instability or the sun; and to the use of clouds of longitudinal and rectangular patterns for long-distance gliding under the name of 'cloud-streets'.

Structure of the Universe

SPEAKING to the Durham University Philosophical Society on February 1 at Armstrong College, Newcastle-upon-Tyne, Dr. Herbert Dingle, assistant professor of astrophysics at the Imperial College of Science and Technology, gave a historical account of the development of our ideas of the structure of the universe. Defining the 'universe' as the whole of physical existence, he pointed out that this apparently general subject demands a treatment which is in many respects unique. The idea of infinity became general with the Renaissance, and this seemed to place the conception of the whole universe beyond the power of the finite mind, until Newton restored the possibility with his implicit concept of universal law which was everywhere applicable. There have been two criticisms of this; a valid objection, that this extension of locally derived law may be incorrect; and an invalid one, based on our imperfect knowledge of atomic processes, which ignores the fact that the laws of a whole can be arrived at without combining the laws of elementary parts. Towards the end of last century, it was argued that the Newtonian law of gravitation was inconsistent with an infinite extension of uniformly distributed matter, of however low a density. Relativity theory, however, made such homogeneity acceptable. The Einstein, de Sitter and expanding universes are widely known nowadays, but Dr. Dingle made it clear that there is nothing esoteric about such theories, and that their underlying principles might have been expected from recent observations even if they had not been discovered when they were. It was stated also that there is no objection to belief in an infinite space, if one is willing to admit that in Einstein's space-time it may be quite beyond physical exploration.

The Uncertainty Principle

In a lecture delivered to the Physical and Chemical Society of University College, Nottingham, on February 4, Prof. E. Schrödinger directed attention to the difficulties and contradictions which arise from attempts to unite quantum theory with geometry and with the theory of relativity. Although the first researches on wave mechanics used the relativity ideas, they are really in flat contradiction to them. The theory of relativity supposes that rods and clocks can be used to measure exact lengths and times, and that in some way velocities can also be measured accurately. Unfortunately, Heisenberg's uncertainty principle, which appears to be inherent in quantum mechanics, lays down that simultaneous accurate measurements of position and velocity are impossible. Moreover, the regulation of a clock is not possible to more than a limited degree of accuracy, except when the clock is infinitely heavy. Similar considerations forbid us to apply our ideas of Euclidean geometry, based upon ideal rigid measuring rods, to small physical regions. Physicists have at least as much confidence in the special theory of relativity as in quantum theory; the problem of devising a unified theory appears to be still unsolved.

A French Chemical News Service

We have before us the first number of *Les Nouvelles de la Chimie*—a new monthly paper issued in Paris. It resembles in its general appearance a daily paper, a fact which may seem unusual in England; in France there exist already several medical news journals having the same format. The front page of the new journal contains news items, interviews and similar topical material; on the second page we find a review of general scientific activities in the universities and laboratories, while the third and fourth pages are devoted to general technical and economic information. The editor of the new paper is M. Jean Gérard, the active director of the Maison de la Chimie and its Centre of Documentation. We understand that if the new venture fulfils the expectations of its promoters, it will develop into a weekly and finally into a daily news service covering not only the field of chemistry but also that of science in general.

Baffin Island Survey

The annual report of the Canadian Department of Marine for the fiscal year 1933–34 contains some interesting information respecting the operations of the Canadian Hydrographic Service during the period under review. Among other technical observations, the Service carried out a survey of the Baffin Island coast, of which the following extract is a partial description. "In aspect, the south-eastern coast of Baffin Island is very bleak, bare rugged hills of gneiss and granite rising to elevations about 600 feet close to the sea and to greater heights inland. The ragged shore is broken by numerous fiord-like inlets, but from Pritzler Harbour to Barrier Inlet, 45 miles north-northwestward, the shore is fronted by many islets, rocks and shoals of a most dangerous character. The 50-fathoms contour, which lies at an average distance of 3 miles off the islands, should be considered the danger line. The country is quite uninhabited except for some Eskimos who travel gregariously along the coast in whaleboats (omiaks). These natives appear to be of a very good type—healthy, honest and well adapted to the rigours of the country. Their habitat is both the north and south coasts of the long peninsula which separates Frobisher bay from Hudson strait. The small, swift rivers which flow into the heads of the inlets are well stocked with a fine species of salmon trout weighing up to 8 lbs.; this food, together with seal, constitutes their chief diet. At certain times a caribou hunt takes place and the hunters travel inland for several days to secure fresh meat. In addition, the country also provides aquatic fowl, ptarmigan, arctic hare and an occasional walrus or polar bear."

Reversing Falls at Barrier Inlet

After recording the absence of good ship harbourage between Pritzler Harbour and Barrier Inlet, the report of the Canadian Department of Marine goes on to describe the physical features of the latter, which is an arm of the sea extending 12 miles inland. At the entrance, it has a width of about a mile and a half, but two miles inside, the width contracts to three quarters of a mile. The channel is still further constricted at this point by a number of rocky islets, connected at low stages of the tide and leaving only two narrow passage-ways less than a hundred yards wide. "The free flow of the tide in and out of the inlet being thus constricted at the narrows, a 'head' of water is formed and creates a reversing falls. At the time of low tide on October 1, there was a sheer outward waterfall 8½ feet in height, and the lowering of the fiordal waters continued for a space of 2½ hours whilst the tide was rising outside at the foot of the cataract. Slack water occurred for a few moments when the flood tide reached the elevation of the water in the fiord but almost immediately the inward rush of water formed whirlpools and great eddies and soon waves, 6 feet high, careened wildly from side to side. A boat attempting to pass through at such time would be engulfed."

American Museum of Natural History: New Director

According to *Science* of January 15, Dr. George H. Sherwood has resigned his post as director of the American Museum of Natural History to give his entire time to the School Service Section as curator-in-chief of education. Dr. Sherwood will remain honorary director of the museum. Dr. Roy Chapman Andrews will succeed Dr. Sherwood as the active head of the museum. As leader of the Central Asiatic Expeditions of the American Museum of Natural History, Dr. Andrews took his first expedition into the field in 1916 to work in the territory of Tibet, South-west China and Burma. His second expedition went into North China and Outer Mongolia in 1919, and the third expedition has worked in Central Asia, especially in Mongolia, since 1921,

where it uncovered some of the richest fossil fields in the world. Dr. Andrews was awarded the Elisha Kent Kane Gold Medal of the Philadelphia Geographical Society, previously given to only eight explorers. Brown University and Beloit College have both conferred on him the degree of honorary doctor of science. He has been given the Hubbard Medal of the National Geographic Society in recognition of his discoveries in Asia. He is well known as a lecturer and author of popular books and articles on the results of his various expeditions, including a large volume covering his entire field work in Mongolia and China up to the present time entitled "The New Conquest of Central Asia".

Organisation of Museums

THE Madrid Conference on Museography on October 28–November 1, 1934, attended by seventy-five experts representing twenty different countries, was noteworthy for the publicity it gave to the organic life led by museums outside their actual exhibition galleries, quite as much as for the success of the Conference in paving the way for a general treatise on the principles and practice of museums. The main object of this Conference, organised by the International Museums Office and the International Institute of Intellectual Co-operation, was to collect observations and the results of actual experience from as large a number of museums and countries as possible, rather than the formulation of general rules. The agenda of the Conference included discussions on the general principles of the architecture of a museum, on museum equipment both in exhibition and other public rooms and in the museum services; on lighting, heating, ventilation and air-conditioning; the conversion of ancient monuments and other buildings into museums; general principles regarding the enhancement of works of art; methods of presenting collections; organisation of stores, reserves and study collections; permanent and temporary exhibitions; problems arising from the growth of collections; exhibition material; plans of rooms and the numbering and labelling of exhibits. A number of special questions such as collections of sculpture, decorative and industrial art, folk-art and ethnography, and graphic and numismatic collections were also discussed. The Academy of Fine Arts, Madrid, was specially fitted up for the Conference by the Spanish Government, and the International Museums Office lent a considerable amount of graphic and photographic documents to illustrate the papers.

Electric Discharge Lamps for Road Lighting

IN many of the long stretches of main roads between towns and villages the only practical way of lighting at present seems to be by means of the lamps on the vehicles. In a paper on "Electric Discharge Lamps and Road Lighting" read to the Institution of Automobile Engineers on December 11, Mr. H. Warren and Mr. L. J. Davies show how the length of the permanent illumination of roads can be extended, with acceptable economy, by means of the new discharge lamps, when care is taken to distribute the light scientifically by means of suitable lanterns. Controlling the reflective properties of the road surfaces has also to be taken into consideration. With mercury and sodium vapours we have two substances which, when excited in the correct way, produce a sufficient proportion of energy in the visible spectrum to give a two- or three-fold increase in efficiency over incandescent lamps. A fifty-fold efficiency is theoretically possible, but the practical utilisation of electrical discharges has just made a beginning. At present, electric discharge lamps for street lighting are of two main types, high-pressure mercury vapour and sodium vapour. The former type of lamp is most favoured in Great Britain, while on the Continent and in America the sodium vapour lamp is most used. Mercury discharge lamps have an excellent 'luminous output' during their lives, which are longer than those of other forms of lamp. The colour of the lamp, when viewed directly, is greenish-white. In the colours radiated, blue, green and yellow predominate, but red is practically lacking. By incorporating cadmium with the mercury a satisfactory red tinge can be introduced, but at a slightly lower efficiency. The colour correction of these lamps is receiving a great deal of attention in commercial research laboratories at present.

Continuously Evacuated Radio Transmitting Valves

AT the meeting of the Wireless Section of the Institution of Electrical Engineers on February 6, a paper entitled "Continuously Evacuated Valves and their Associated Equipment" was read by Mr. C. R. Burch and Dr. C. Sykes. This paper describes the development of demountable thermionic transmitting valves of various power ratings, the valves being evacuated continuously by means of oil condensation pumps. This work has arisen out of some experiments carried out in 1929 on the distillation of lubricating oil in a molecular still. It was found that one of the fractions was about a thousand times less volatile than mercury, so that if such a liquid could be used as the working fluid in a condensation pump, a vacuum of the order of 10^{-6} mm. should be attainable without the use of liquid air or other refrigerants; and such a vacuum is quite adequate for valve exhaustion. These expectations have been fully realised in the development of oil-condensation pumps which will work against a fore-vacuum of 0·05 mm. and will produce a vacuum of 10^{-5}–10^{-6} mm. at a speed of 20 litres per second. Such pumping equipment is described in the paper in some detail, and reference is made to its application to the production of thermionic valves of a power rating ranging from 20 kw. to 500 kw. for high-frequency furnaces and for radio transmitting stations. Several valves of the 30 kw. order have been in use on commercial radio traffic at the Post Office station at Rugby for long periods, and they have given satisfactory service. A 500 kw. valve is in the stage of experimental trial on the long-wave transmitter at Rugby. The relative merits of these valves and those of the sealed-off type were discussed

briefly in the paper, and were enlarged upon by several speakers in the discussion which followed the reading of the paper.

Deep-Sea Observations with the Bathysphere

FOUR years ago, Dr. William Beebe and Mr. Otis Barton descended in their 'bathysphere'—a steel ball fitted with quartz windows—to a depth of a quarter of a mile below the surface of the ocean off Bermuda. During the season of 1934 they successfully established a new depth record of 3,028 ft. In the *National Geographic Magazine* of December 1934 and the *Bulletin of the New York Zoological Society* of November–December 1934, interesting articles deal with the fitting-out, operation and scientific observations made, during these latest dives. Excellent photographs in the text provide a word picture of the undertaking, and a series of coloured plates give vivid impressions of the strange and bizarre forms of life as seen by Dr. Beebe through the windows of the ball and described over the telephone line between the bathysphere below and the parent ship at the surface. Three deep-sea fish, new to science, are described, including the five-lined constellation fish, *Bathysidus pentagrammus*, which Dr. Beebe speaks of as one of the most gorgeous deep-sea inhabitants he has ever seen. Five rows of photophores emitting yellow and purple light produced a beautiful pattern of illumination through the darkness. From this and other records, there can be little doubt as to the success and scientific value of this daring method of observation.

Optical Research

AT the meetings of the Institut d'Optique, held periodically at the Sorbonne and generally under the chairmanship of Prof. Charles Fabry, director of the Institut, the communications considered relate as a rule to one particular branch of the subject, and the *Revue d'Optique Theorique et Instrumentale* issues a separate copy of the proceedings which may run to as much as 50 pages. Last year, the January meeting dealt with the employment of liquid prisms in spectrographs, that of March with interference methods of studying movements of the air, the April meeting with ultra-violet polarimetry and with the densities of photographic images, and the June meeting with the light of the night sky. In several cases the subject is introduced by a short sketch of past work on it and its present aims and problems, given by the president, and descriptions of current methods and instruments by specialists in the subject follow. These pamphlets seem capable of affording great assistance to those requiring brief résumés of the present positions of the various branches of optical research.

Systematics of the Diptera

MR. P. H. GRIMSHAW has recently published a useful article entitled "Introduction to the Study of Diptera, with a Key for the Identification of Families" (*Proc. Roy. Phys. Soc., Edin.*, **22**, Pt. 4, July 1934). The paper gives a clear account, accompanied by illustrations, of the various structural features of importance in classification. A list of the chief general works on the order is provided and a diagnostic key to all the existing families. The key is translated and adapted from Lindner's "Fliegen der palaeartischen Region" and should prove especially valuable to those entomologists who are not specialists in the insect order concerned.

Review of Seismology

THE National Research Council of the National Academy of Sciences at Washington is issuing a series of bulletins on the physics of the earth, to give scientific workers who are not specialists in the subjects treated an idea of the position and problems of various branches of geophysics. Among the bulletins in this series which have already been issued are those on volcanology, the figure of the earth, meteorology, the age of the earth and oceanography. Recently, Bulletin No. 90 on seismology has appeared. It has been prepared by a Committee of which Prof. J. B. Macelwane is chairman. Within 219 pages it includes twenty chapters, and gives a very valuable and interesting general view of the subject. Chapters by the chairman include—the definition and classification of earthquakes, tectonic earthquakes, plutonic earthquakes, rock fall earthquakes, body waves, reflection and refraction of seismic waves, surface waves and paths and velocities of seismic waves within the earth; H. O. Woods contributes articles on volcanic earthquakes, field investigation and surface geology in relation to the 'apparent' intensity; articles by H. F. Reid deal with magnetic effects, earthquake mechanics and with the focus. The principle of the seismograph is described by J. A. Anderson, and P. Byerly contributes five articles on analysis of seismograms in earthquakes, records at intermediate and great distances, time distance curves, reduction of trace amplitude, and seismic geography. The Bulletin has numerous bibliographies and is priced at 2 dollars.

Books on Anthropology and Archæology

CATALOGUE No. 574 (Anthropology and Folklore—Archæology and Ethnography) issued by Messrs. Francis Edwards, Ltd., 83 High Street, Marylebone, London, W.1, including both new and second-hand books, though, naturally, the latter predominate, contains just under a thousand items. On looking through the list, two points occur, one being the high average in the quality of the books from the point of view of the anthropologist, and secondly the fact that, with certain exceptions, the prices do not rule high. With regard to the first point, the subjects covered by the catalogue, it is almost needless to say, have been a happy hunting ground for the wilder theorist and speculation has been rife in their literature. It is evident that here on the whole a wide discretion has been exercised in selection. The question of price is no less interesting. It is not intended to convey that this catalogue is an exceptional opportunity for bargain hunters—although it would be possible to form from its pages an excellent nucleus of a reference

library in anthropology at a very moderate price—but rather that the rarities, and even some of the older standard books which command a high price, are becoming increasingly rare. Among the items to be noted are some complete runs of scientific publications, such as the Folklore Society's publications and those of the Royal Anthropological Institute, some lengthy runs of *Archæologia* and a virtually complete set of the *Journal of the African Society*, of which certain numbers are now impossible to obtain, except by fortunate accident. A noteworthy item is Edge-Partington's ethnographic album of the Pacific, of which, it is thought, not more than half a dozen copies are now in existence in private hands.

Announcements

THE following have recently been elected foreign members of the Royal Academy of Sciences, Stockholm: Prof. Robert Robinson, professor of chemistry in the University of Oxford; Prof. F. D. Adams, emeritus Logan professor of geology in the McGill University, Montreal; Prof. Ejnar Hertzsprung, professor of astrophysics in the University of Leyden, Holland; and Prof. A. V. Hill, Foulerton research professor of the Royal Society, formerly Jodrell professor of physiology in University College, London.

AT the annual general meeting of the Royal Astronomical Society held on February 8, the following officers were elected: *President:* Mr. J. H. Reynolds; *Vice-Presidents:* Prof. S. Chapman, Dr. H. Spencer Jones, Dr. H. Knox-Shaw, Prof. F. J. M. Stratton; *Treasurer:* Sir Frank W. Dyson; *Secretaries:* Mr. W. M. H. Greaves and Dr. W. M. Smart; *Foreign Secretary:* Prof. Alfred Fowler.

MR. B. H. WILSDON has been appointed to the post of director of research to the Wool Industries Research Association at Torridon, Headingley, Leeds. Since 1929, Mr. Wilsdon has been assistant director and superintendent of the Building Research Station of the Department of Scientific and Industrial Research. He was educated at Lincoln College, Oxford, and after a period of research there, went to India as a professor of chemistry, afterwards gaining varied experience in applied research in agriculture and organising the Irrigation Research Institute of the Punjab. Besides publishing work on chemical and physical subjects, Mr. Wilsdon has done pioneer work on the application of statistical methods to industrial problems of specification and standardisation.

In NATURE of February 9 (p. 212), it was stated, following the Report for 1933–34 of the Department of Scientific and Industrial Research, that the new process of the Wool Industries Research Association for the production of unshrinkable fabrics is being exploited under mill conditions and that materials should be available to the public early this year. We are informed by the Association that work still remains to be done on the problems which occur in transferring the operation of such a process from the laboratory to a commercial scale, and that "it is certain that underwear or other knitted materials, finished by application of the W.I.R.A.'s new unshrinkable process, will not be available to the Trade before 1936".

THE Secretary of State for the Colonies has made the following appointments: Mr. R. M. Gamblen, to be veterinary officer, Cyprus; Mr. J. D. Tallantire, to be superintendent of agriculture, Nigeria; Mr. J. M. S. Usher-Wilson, to be superintendent of agriculture, Nigeria; Mr. R. L. Brooks (deputy conservator of forests), to be conservator of forests, Trinidad; Mr. P. E. Carcenac (assistant conservator of forests, Mauritius), to be assistant conservator of forests, Malaya; Mr. J. de Meza (veterinary bacteriologist), to be chief veterinary officer, Nyasaland; Mr. J. C. Muir (superintendent of agriculture, Gold Coast), to be senior agricultural officer, Zanzibar; Mr. F. B. L. Butler (grader and inspector, Agricultural Department, Kenya), to be chief grader and inspector of produce, Agricultural Department, Cyprus.

THE twenty-fifth Dutch Congress of Natural Science and Medicine will be held in Leyden on April 23–25 under the presidency of Prof. J. van der Hoeve with Prof. L. G. M. Baas Beching as president of the biological section and Prof. E. Gorter as president of the medical section. Further information can be obtained from the general secretaries, Dr. D. Coelingh, Regenteslaan 2, and D. N. R. Pekelharing, Jr., Meentweg 48, Bussum.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Probationer mapping assistants to H.M. Land Registry—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1 (Feb. 21). A head of the Engineering Department of the Willesden Technical College—The Secretary, H. M. Walton (T.), 10 Great George Street, Westminster, S.W.1 (Feb. 22). A lecturer in electrical engineering at Norwich Technical College—The Principal (Feb. 25). A lecturer in electrical engineering at Chesterfield Technical College—The Director of Education, County Education Office, St. Mary's Gate, Derby (Feb. 25). A computer (Class II, male or female) for the Ordnance Committee, Royal Arsenal, Woolwich, S.E.18—The Secretary (Feb. 25). A principal of the South-East Essex Technical College—The Director of Education, County Offices, Chelmsford (Feb. 28). A lecturer in pathology in the University of Bristol—The Registrar (March 1). A lecturer in bacteriology in the University of Manchester and assistant bacteriologist in the Public Health Laboratory—The Secretary, University, Birmingham 3 (March 1). Junior scientific officers at the National Physical Laboratory to work in the Aerodynamics and Radio Departments—The Director (March 4). Probationary assistant engineers in the Post Office Engineering Department—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1 (March 7). A lecturer in anatomy and deputy-director of the Department at St. Thomas's Hospital Medical School, Lambeth Palace Road, London, S.E.1 (March 16). Laboratory assistants (male) at the Experimental Station, Porton, near Salisbury—The Commandant.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 271.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Viscosity of Helium I and Helium II

DETERMINATIONS have recently been made in the Cryogenic Laboratory at Toronto of the viscosity of liquid helium in its two states, helium I and helium II.

Helium I denotes the liquid as it first forms at a temperature of 4·2° K. When the pressure above the liquid is progressively reduced, the temperature falls and the liquid bubbles freely as it boils under the reduced pressure. Suddenly, when a temperature of 2·2° K is reached, the liquid changes its state—a change indicated by complete cessation of boiling, although the temperature continues to fall as pumping is continued.

The viscosity of liquid helium was measured, step by step as the temperature was reduced, by means of observation of the logarithmic decrement and periodic time of the oscillation of a circular metal cylinder submerged in the liquid helium. The cylinder was 2·5 cm. in diameter, and 8·5 cm. in length over all, the top and bottom being bevelled in the form of cones, each 2·1 cm. in height. From the top of the cylinder a stiff phosphor-bronze rod 0·07 cm. in diameter extended 62·5 cm. The rod and cylinder were suspended by a fine phosphor bronze ribbon 14·0 cm. long. The rod was sufficiently long to ensure that the suspension wire was kept at room temperature.

Fuller reports of the experiment will be made elsewhere: the results only are announced here.

Helium I at 4·2° K:	$\eta = 0{\cdot}00011$	c.g.s. units
Helium I at 2·3° K:	$\eta = 0{\cdot}00027$	„ „
Helium II at 2·2° K:	$\eta = 0{\cdot}000033$	„ „

To show the definiteness of the viscosity change we may cite the following. During the course of the experiments the cylinder was set swinging in helium II (<2·2° K) and the pressure over the helium liquid was allowed to change to that corresponding to a temperature of 2·7° K. The cylinder continued to oscillate throughout the interval of this change of temperature, but as the state of the liquid changed from II to I, there was a very distinct and abrupt change in the logarithmic decrement, which corresponded to the above changes in the coefficient of viscosity.

This work was carried out by Messrs. Wilhelm, Misener and A. R. Clarke.

E. F. BURTON.

McLennan Laboratory,
University of Toronto.
Jan. 9.

An Application of Infra-Red Photography to Palæobotanical Research

TRANSFER preparations of fossil plants, particularly those of Carboniferous age, provide the palæobotanist with the plant remains separated from the rock matrix and mounted on a transparent base of Canada balsam or cellulose ester. While many of these fossil remains are translucent and give the investigator the opportunity of studying some of their microscopic features by transmitted light, many are opaque with ordinary types of illumination.

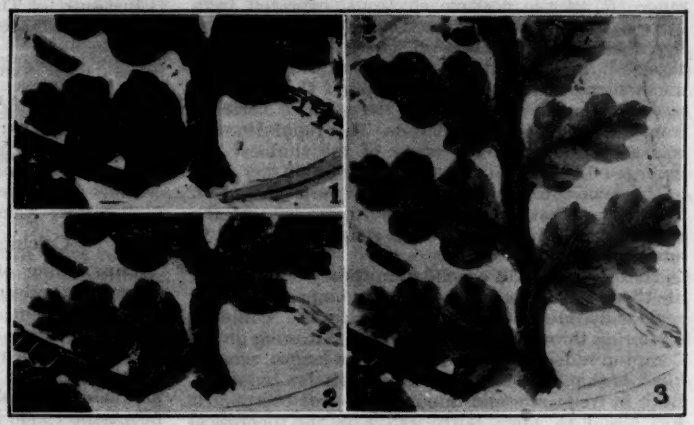

FIG. 1. Photographs of transfer preparation of a fossil plant: (1) by ordinary photographic plate; (2) by panchromatic plate; (3) by infra-red plate.

It has been found that some of these apparently opaque fossils are translucent with respect to infra-red rays, and photographs taken on plates sensitive to the infra-red part of the spectrum reveal quite a considerable amount of detail otherwise invisible. The accompanying illustration (Fig. 1) includes (1) a photograph by transmitted light of a fossil plant of Coal Measure age taken on an ordinary photographic plate; (2) is the same subject taken on a panchromatic plate with a dark red filter; and (3) is the same subject taken on an infra-red plate with an infra-red filter. The exposure required with the panchromatic plate was considerably longer than that required for the two other photographs. The exposure with the infra-red was one minute. The magnification is in each case 6·5.

It is clear that since this fossil is a thin layer of coal, this method of examining carbonaceous fossil plants may be very effective in coal petrology in the examination of coal in thin sections.

JOHN WALTON.

Department of Botany,
University, Glasgow.
Jan. 15.

Scattering of Hard γ-Rays and Annihilation Radiation

To determine the relative importance of the annihilation of positive electrons in the phenomenon of the 'scattering' of hard γ-rays, observations were made on the secondary γ-radiation from thin lead foils irradiated with thorium C″ γ-rays (25 mgm.). With a scattering angle of about 140°, 0·8 cm. effective lead filter was sufficient to absorb practically all the Compton scattering, and still leave predominant the softer of the two components in the anomalous scattering, namely, the component which has been attributed to the annihilation of positive electrons.

A sheet of paraffin wax was placed in front of the source to reduce to a minimum the number of positive electrons falling on the scatterer. Measurements were made on the secondary γ-radiation from foils of varying thicknesses (t) down to thicknesses of the order of, and appreciably less than, the average range (R) of the positive electrons, expected from theory, from the γ-rays used. If the annihilation hypothesis is correct, the 'scattered' radiation under these conditions should, in the region $t \sim R$, decrease much more rapidly with decreasing t than its first power, owing to the escape of the positive electrons from the foil before annihilation. This rapid decrease was actually found, the effect of the thinnest foil used ($\sim 0{\cdot}002$ cm.) being only about 30 per cent of the value corresponding to a linear variation with t. This shows that at least about 70 per cent of the scattered radiation under these conditions is due to annihilation[1].

To test further the annihilation theory of the origin of the *soft* component, it was compared, under practically identical conditions, with the Compton scattering through 79°, this angle of scattering giving Compton radiation of the same wave-length, namely h/mc, as that of the theoretical annihilation radiation. Both in frequency and intensity the soft component was found to agree fairly well with the theoretical expectations, and there is no question, according to the present experiments, of the annihilation radiation being only a small fraction of the theoretical value, as maintained by Bothe and Horn[2]. The theoretical intensity was estimated in the usual way from the number of positive electrons produced by the primary γ-rays according to Dirac's theory[3].

To investigate the *hard* component in the anomalous scattering, observations were made with different thicknesses of lead filter in the path of the secondary rays, up to 5 cm. of lead at 140°, and up to 7 cm. at 80°. While a slight progressive hardening was found with increasing filter strength, throughout this range, there was no evidence for secondary radiation of primary hardness. Actually, with the maximum filter thickness, the secondary radiation was definitely softer than the hard γ-rays from radium C. The latter correspond to a quantum energy of about $1{\cdot}9 \times 10^6$ volts, while the effective primary radiation in the above experiments has a quantum energy of $2{\cdot}65 \times 10^6$ volts.

The initial intensity of the hard component from lead is of the order of 15 per cent of that of the half-million volt radiation. It is somewhat anisotropic, being more intense at 80° than at 140°. The anisotropy is more pronounced for light elements. These results are qualitatively in agreement with the supposition that the hard component is due to X-radiation from Compton electrons, and the annihilation of positive electrons before reaching the end of their range, the degree of anisotropy of such tertiary radiations being dependent on the atomic number through the nuclear scattering of the secondary electrons. The importance of the first of these processes has already been emphasised by Lauritsen and Oppenheimer[4], and from more recent and detailed calculations by Wheeler and Plesset[5] it appears that the two processes will account for at least a large part of the hard component.

A fuller account of the experiments described in this note, and of a more detailed analysis of the results when completed, will be published in due course. The experiments were carried out at the laboratory of the Institute for Theoretical Physics, Copenhagen, and I should like to take this opportunity of thanking Prof. N. Bohr for his kind interest in the investigation, and also Dr. J. C. Jacobsen and Mr. K. F. Brostrøm for their valuable assistance in the experimental work.

E. J. Williams.

Institute for Theoretical Physics,
Copenhagen. Jan. 12.

[1] Cf. earlier experiments by the writer using 0·1 mm. lead foil and radium C γ-rays (NATURE, 133, 415; 1934).
[2] *Z. Phys.*, 88, 683; 1934.
[3] Oppenheimer and Plesset, *Phys. Rev.*, 44, 53; 1933. Bethe and Heitler, *Proc. Roy. Soc.*, 146, 83; 1934.
[4] *Phys. Rev.*, 48, 80; 1934.
[5] To be published in the *Physical Review*. These authors have also considered other possible effects, including the Raman scattering of the primary radiation, and found them to be unimportant.

Colchicine and Tumour Growth

The finding of considerable numbers of mitotic figures in the haemopoietic organs of normal healthy animals and in the neoplastic tissues of tumour-bearing animals after colchicine administration has led many students to suspect an inter-relationship between mitosis and the alkaloid. But the effect of colchicine in slowing down the rate of growth of neoplastic tissue has not been reported.

Following on some earlier observations (unpublished, 1927) which I made in conjunction with the late Prof. M. R. J. Hayes on the beneficial effects of deep X-ray therapy on neoplasms in patients suffering from acute attacks of gout, which were being treated with colchicum, a series of experiments was recently planned with the object of determining to what extent the colchicine might affect new growths.

In one of these, a group of twelve tumour-bearing mice (*M* 63), were injected subcutaneously on alternate days with small doses of colchicine (kindly supplied by the director of the Wellcome Bureau of Scientific Research, where the work was carried out). Treatment lasted for a period of two weeks. Twelve other tumour-bearing mice were used as controls. The tumours at the end of the first week showed much less growth as compared with the controls; while at the end of the second week there was no macroscopically recognisable tumour tissue present in 66·6 per cent of the injected animals, and only minute nodules could be detected in the remaining 33·3 per cent. These nodules finally showed complete regression, and no tumour tissue could be recognised eight weeks later. The controls in all but one instance showed a marked development of the tumour. In another series, the percentage of animals in which there was no recognisable tumour tissue at the end of two weeks was 100 per cent.

From the effects observed in these tumour-bearing mice, it was thought advisable to determine what

effects, if any, could be obtained in dogs with spontaneous tumours. Of several dogs treated or undergoing treatment with colchicine, the changes observed in a spontaneous tumour in the peritonsillar region in one of these animals is sufficiently striking to warrant recording.

Case history: Sealyham, 11 years old. Difficulty in swallowing biscuits observed about August 26, 1934. By September 30 a marked tendency for holding his head on the left side had developed. On November 19 it was difficult and painful to open the mouth. The difficulty in deglutition had increased, and the animal was unable to bark. On examination there was seen an ulcerated tumour on the left side of the bucal mucous membrane just ventral to the anterior pillars of the fauces on the left side, about the size of a walnut. The dog was admitted to the Royal Veterinary College on December 19, 1934, and injections of colchicine were begun, following on the clinical diagnosis of epithelioma. Injections were continued on alternate days and on January 9, 1935, a small portion of the tumour was excised for histological examination. The clinical diagnosis was confirmed. The administration of colchicine was continued and the tumour inspected daily. There was a progressive diminution in the size of the growth, and on January 29 only a small scar remained at the site of the original growth.

These experiments are being continued with various transplantable tumours, and a number of animals with spontaneous tumours are being treated with colchicine.

The significance of these and other facts relating to the effects of colchicine in man and other animals, as well as the effects of such agents as X-rays and radium in combination with colchicine on new growths, will be published and discussed in collaboration with Dr. G. M. Findlay, of the Wellcome Bureau of Scientific Research, to whom I am indebted for facilities and assistance in carrying out this research.

E. C. AMOROSO.

Royal Veterinary College,
London, N.W.1.
Feb. 4.

Identity of Vitamin B_2 and Flavine and the Nomenclature of Vitamins

ELVEHJEM and Koehn have stated[1] that vitamin B_1 and flavines are not identical. Now Elvehjem and Koehn work with chicks, while Goldberger and others, who were the first to adopt the notation '*P-P* factor', which was afterwards called vitamin B_1, have used dogs and rats for their experiments. The first symptom that they describe for their rats was "a tendency of the lids of one or both eyes to adhere together with, in some instances, an accumulation of dried secretion on the margins of the lid".

It is precisely this pathological condition which we have been able to cure by lactoflavine. The lactoflavine that we used was prepared from milk, according to the methods devised by Kuhn. Further, Miss Chick and others, who were among the first to use the notation vitamin B_2, found that a preparation of egg-white is rich in vitamin B_2. Mr. Tierie, in our laboratory, found, on exposing that extract from egg-white to sunlight, that the vitamin is lost; this suggests that this vitamin, which Miss Chick called vitamin B_2, is a flavine. Therefore I think that Kuhn is right in calling his lactoflavine vitamin B_2.

These investigations demonstrate, I think, that we are adopting the wrong method in our nomenclature of vitamins by denominating them according to the letters of the alphabet. When we isolate more of them—and I am sure there are still several as yet unknown vitamins—we have the trouble of giving them the right letters, and there is again the danger that two investigators may claim the same letter for quite different substances, as is the case with vitamin B_2. Also, the old system is not at all logical: vitamins B_1 and B_2 are not only quite different substances, but have also very different actions; on the other hand, vitamins D_1 and D_2 probably do not differ very much in structure, and in action differ only quantitatively.

I should like to propose, therefore, to omit all these letters in the denomination of vitamins. The vitamins that are isolated in a pure state should be given their proper names, as has already been done for some of them. So long as they remain unisolated, they may receive a provisional name, just as in the case of hormones. Hence vitamin A may provisionally be called anti-xerophthalmic-vitamin.

Further, I propose to call the present vitamin B_1 in the future aneurin (from a[nti-poly]neur[itis vitam]in). I think I have some right to propose this, as Dr. Donath and I were the first to obtain this vitamin in a crystalline state.

Of the other B-vitamins, one is called flavin. Whether this is the specific anti-pellagra vitamin or not may soon be known, when the pure flavin is tested on human pellagra patients.

Vitamin C is already called ascorbic acid by Szent-Györgyi, which name has come into general use.

One preparation of vitamin D is already called calciferol. As soon as the antirachitic factor from cod liver oil, which is certainly a different substance from calciferol, is prepared in a pure state, it will receive a name.

The E vitamins may provisionally be called sex-vitamins or anti-sterility vitamins.

It is a pity that there is no international committee to regulate this nomenclature.

B. C. P. JANSEN.

Laboratory for Physiological Chemistry,
University, Amsterdam. Jan. 24.

[1] NATURE, 134, 1007; 1934.

Aluminium Chloride as a Catalyst of Hydrogen Interchange

THE Friedel Crafts reaction:

$$RCl + C_6H_6 \xrightarrow{AlCl_3} C_6H_5R + HCl$$

suggests the use of $AlCl_3$ as a catalyst for the interchange of hydrogen between benzene and hydrogen chloride. We have found this expectation confirmed in the following experiments: 0·5 gm. of $AlCl_3$ was brought into contact, for three hours, in a vessel of about 100 c.c. capacity, with a mixture of ordinary benzene and hydrogen chloride containing 13·4 per cent D, the temperature in two runs being 25° and 50° respectively:

Temp.	Benzene.	Pressure of hydrogen chloride.	Per cent D in hydrogen chloride after treatment.
25°	0·107 g.	178 mm.	1·23
50°	0·095 g.	297 mm.	1·08

From the analysis of the hydrogen chloride given in column 4, it follows that in both cases more than 90 per cent of the D had passed over from the hydrogen chloride into the benzene. This has been confirmed by analysing the benzene formed. We have found indications that under the above experimental conditions the reaction proceeds to some extent, even when no $AlCl_3$ is present; but in this case it goes at a much slower rate.

J. KENNER.
M. POLANYI.
University of Manchester. P. SZEGO.

Crystal Structure of Cyanuric Triazide

IN connexion with the discussion on dipole moments held by the Faraday Society at Oxford in April 1934, Sir William Bragg described[1] briefly the results of a research, which I had been making on the structure of cyanuric triazide. A Fourier analysis of the measured X-ray intensities of (*hkio*) planes showed the three nitrogen atoms of the azide group to be in a straight line[2]. Details of the research were promised later and were held up for an absolute intensity determination to be made. The calculations are now completed and will, I hope, be published soon.

Mr. E. W. Hughes has now published[3] a structure which resembles mine, but differs from it in certain important features. He shows the azide group as departing from linearity by 15°, while I find that any departure from the straight line could not exceed 3° or 4°. The distances between the centres of the atoms in the cyanuric ring he finds to be all equal, thus indicating an oscillating double bond as in benzene. I find these distances alternately larger and smaller, corresponding with fixed single and double bonds respectively. The inter-atomic distances which I find are not in complete agreement with his. Mr. Hughes's estimates of the intensity of X-ray reflections were made by eye and I cannot think this a sufficiently safe or accurate method for the purpose. My measurements were made by means of a Robinson photometer and put on an absolute scale by the accurate method of the ionisation chamber.

I. ELLIE KNAGGS.
Davy Faraday Laboratory,
Royal Institution, W.1.

[1] NATURE, 134, 138; 1934.
[2] *Trans. Far. Soc.*, 30, 826; 1934.
[3] *J. Chem. Phys.*, 1; 1935.

Spectra and Latent Energy in Flame Gases

IN a recent letter on the above subject, Prof. W. T. David[1] points out that after flame has travelled through an inflammable gaseous mixture, the gases remaining emit luminous (visible and ultra-violet) radiation for a considerable period of time if their temperature is kept up. In an investigation carried out at the United States Bureau of Standards, accounts of which have already appeared[2,3,4], evidence of prolonged emission in the infra-red was obtained from observations of flame in the cylinder of an engine delivering power.

Infra-red radiation (to about 11μ) was recorded from explosions in a small single cylinder L-head engine, through fluorite windows let into the engine head. The fuels used were benzole, and benzole blended with a low-grade petrol. Observations were made of a small depth of charge perpendicular to the direction of flame travel, so that radiation was successively recorded from unburned charge ahead of the flame front, from the flame front, and from gases remaining behind the flame front. Curves of radiation against crank angle were initially horizontal, rose sharply (at the instant visible flame appeared under the window in use) to a maximum, and then decreased gradually.

From gases under a window adjacent to the sparking plug, radiation from non-knocking explosions reached a maximum slightly before maximum pressure was recorded in the cylinder, and at the same instant visible flame appeared under another window, slightly more than 10 cm. away in the direction of flame travel. (This distance corresponded to 20°–25° of engine crank rotation.)

From gases in the 'knocking zone', radiation from non-knocking explosions continued to rise for 20° of crank angle after the arrival of visible flame: in knocking explosions visible flame arrived earlier, and a higher maximum radiation was reached, 15° later as against 20°. For both non-knocking and knocking explosions, maximum pressure in the cylinder preceded maximum radiation.

Later in the cycle, both radiation and pressure curves for knocking explosions were below those for non-knocking, indicating greater loss of energy from the charge involved in the knock.

The fact that radiation through a given window continued to rise for approximately 20° of crank angle after the arrival of flame under that window was taken as evidence that formation of H_2O and CO_2 molecules continued for at least this period, and probably longer, after inflammation. Some doubt was consequently expressed concerning the assumption, based on oxygen determinations at successive moments during the cycle, that combustion is completed in a narrow flame front[5].

It may be that, in an engine cylinder, some metastable H_2O and CO_2 molecules are formed, which then part with their latent energy, either communicating it to neighbouring molecules or emitting radiation on the wave-lengths characteristic of H_2O and CO_2. This would make it easier to reconcile the 20° lag between the appearance of flame and the attainment of maximum radiation in the infra-red, with the shorter period required for combustion to be completed in a narrow flame front. It is also possible that the phenomenon of fuel-knock may be connected with the proportion of metastable molecules formed during combustion.

SYDNEY STEELE.
7, Sefton Avenue,
Widnes, Lancs.
Dec. 9.

[1] NATURE, 134, 663; 1934.
[2] Steele, NATURE, 128, 185–6; 1931.
[3] Steele, *Ind. Eng. Chem.*, 25, 388–93; 1933.
[4] Marvin, Caldwell and Steele, National Advisory Committee for Aeronautics, Technical Report No. 486; 1934.
[5] Withrow, Lovell and Boyd, *Ind. Eng. Chem.*, 22, 945; 1930.

Diamagnetism of Light and Heavy Water

THE molecular diamagnetism of light water, 12·97, has been closely approached in the values hitherto published for heavy water: 12·90[1] and 12·76[2]. A coincidence has been observed in this department by J. H. Cruickshank, using a Curie-Chéneveau magnetic balance: the molecular diamagnetism of heavy water was $12·96 \pm 0·02$. Additional measurements

on light/heavy water mixtures, containing 44, 62 and 87 per cent of heavy water, showed strictly additive susceptibility. H_2O, D_2O and HDO therefore appear to have identical molecular diamagnetisms, and to have no influence on one another's magnetism.

J. H. Cruickshank, however, has carried out a more refined measurement, and noticed a peculiar lag in which appears an observable magnetic difference between the two waters. The change in susceptibility of freshly melted water, the temperature of which had been allowed to rise to that of the balance, 18° C., was followed over a period of 30 minutes after melting by continuously reading the deflexions. The readings gradually increased to a maximum at 20 minutes after melting, and then fell slightly to a constant value.

According to recent views[3,4], the state of co-ordination of water is such that the molecules are, for geometric reasons, held farther apart than they would be in a state of closest packing. Therefore, although the local effect of co-ordination is to lower the diamagnetism at the bonds, the volume effect prevents depression at other points and keeps the diamagnetism up. In ice, co-ordination is a maximum; in freshly melted water, there is a lag in deco-ordination shown by a continuous change in the susceptibility. This change is an increase to begin with, because the deco-ordination local effect (with its rise of diamagnetism) is predominant. Later, the corresponding volume effect (with its fall of diamagnetism) becomes more effective, as seen in the development of a maximum value.

In heavy water, both the increase in susceptibility to the maximum value and the subsequent fall to constant value are less than in light water, but take place in the same time. Deco-ordination in heavy water tends to take place less readily than in light; but the higher degree of co-ordination in the equilibrium state, and the accelerating effect on deco-ordination of the higher initial temperature, 3·8° C., counteract this tendency, with the result that equilibrium is reached in the same time as for light water. The rise to and the fall from the maximum susceptibility are less because the total loss of co-ordination required to reach equilibrium is less and thus there is less scope for display of lag.

It has been assumed that the temperature of the water rose to 18° C. before the observations were begun, but the rise in susceptibility due to a still rising temperature requires to be added to the rise in susceptibility due to the local effect of deco-ordination. This makes the rise to the maximum greater than the fall to the equilibrium.

During an ordinary determination of susceptibility, the lag described here escapes observation because it is finished long before the constant can be determined.

The same experiment was tried with benzene m.p. 5·4° and aniline m.p. −8°, but in neither case was a maximum observed, although it could be seen repeatedly with the waters.

FRANCIS W. GRAY.
JAMES H. CRUICKSHANK.
Department of Chemistry,
University, Aberdeen.
Dec. 17.

[1] Selwood and Frost, *J. Amer. Chem. Soc.*, **55**, 4335; 1933.
[2] Cabrera and Fahlenbrach, *Naturwissenschaften*, **22**, 417; 1934.
[3] Bernal and Fowler, *J. Chem. Phys.*, **1**, 515–548; 1933.
[4] R. H. Fowler, *Proc. Cam. Phil. Soc.*, **10**, 225–241; 1934.

Spectrum of Doubly Ionised Iodine

WORK on the identification of the lines belonging to this spectrum was begun more than four years ago and a preliminary announcement on a clue obtained which was expected to lead to an analysis of the spectrum was made at the time in these columns[1]. That clue, however, did not lead to the expected result, and had to be abandoned. Finally, it was realised that the only way of solution, though necessarily a very lengthy and tedious one, was to find all possible differences between the wave-numbers ascribed to this spectrum.

For this purpose the measurements made by Kerris[2] were used and, confining the frequency differences up to within about 15,500, nearly 35,000 subtractions were effected. From these has been sorted out what is believed to be a genuine regularity among 50 lines of the spectrum. The agreement among the various differences occurring in this intercombination is of the order of 0·2. This has led to the identification of most of the terms in the 6*s* and 6*p* levels and a few in the 5*d* level. The relative values of the terms are:—

6*p* level:	0, 68·5, 1731·0, 2790·7, 4851·0, 5071·4, 6587·1, 8193·7, 10965·2, 12988·9.
6*s* level:	28222·3, 29630·3, 29908·9, 30272·0, 30503·0, 32839·7, 35299·4.
5*d* level:	24618·6, 27004·7, 40686·6.

Details of the work up to date are being sent for publication in the *Indian Journal of Physics*.

J. B. SETH.
Physics Laboratory,
Government College, Lahore.
Dec. 24.

[1] NATURE, **127**, 165; 1931.
[2] *Z. Phys.*, **60**, 20; 1930.

'Viscacelle' as a Material for making Compensating Plates and Wedges for the Polarising Microscope

'VISCACELLE' (cellulose sheet manufactured by Messrs. Courtaulds by the viscose process and used extensively as a wrapping material) is birefringent. There seems little doubt that this property is due to a net orientation of the long cellulose molecules caused by the unidirectional tension to which the sheet is subjected while being 'spun'. Under this tension, the molecules may be expected to arrange themselves so that their length directions are parallel or nearly parallel to the direction of tension. This explanation is supported by the fact that the direction of tension (revealed on cut sheets by parallel streaks) is the 'slow' direction of vibration.

The accompanying table gives some relevant properties of specimens of different grades of 'Viscacelle' supplied by Messrs. Courtaulds. The relative retardations were deduced from the polarisation colours by means of Lévy's colour chart of birefringences.

Manufacturer's Classification	Thickness (mm.)	Polarisation Colour and Relative Retardation (mμ)
300 Ordinary, Grade 1	0·020 – 0·025	(3 layers) purplish red, *c.* 575
300 Ordinary, Grade 2	0·020 – 0·025	(3 layers) orange red, 450–480
400 Ordinary, Grade 1	0·025 – 0·030	(3 layers) bright blue, *c.* 650
600 Ordinary, Grade 1	0·040 – 0.045	(1 layer) pale yellow, 300–340 (2 layers) bright blue, *c.* 650
300 Moistureproof, Grade 1	0·020 – 0·025	(3 layers) bright blue, *c.* 650

The figures show that the thinnest specimens ("300" grades, 0·020–0·025 mm.) have, in single layers, relative retardations approaching, though in the main somewhat greater than that of the quarter-wave mica plate, and a strip of the material bound between two glass slips by means of pieces of gummed label can in fact be used as a satisfactory substitute for this accessory. Three layers of the "300 Ordinary" mounted in the same way can be used in place of the unit retardation selenite plate, whilst a stepwise pile of strips affords an alternative to the mica stepped wedge or quartz wedge. The colours given by such a wedge appear to be quite normal.

It must be emphasised that the figures in the table refer to particular specimens. However, I have examined a number of other specimens taken from proprietary articles without finding wide deviations, and it seems that the birefringence of the material may be taken as roughly constant for a given thickness. It may happen that several specimens of the "300" thickness have to be tried before one is found from which a sensitive red can be built up. It may be mentioned that the higher birefringence of the moistureproof sample (last in table) as compared with others of the same thickness is not connected with its protective coating, for when this was dissolved off with a mixture of acetone and ethyl acetate, no apparent decrease in the birefringence was observed.

I am indebted to Messrs. Courtaulds for supplying graded samples and for information concerning the manufacture and properties of the material.

N. H. HARTSHORNE.

University College,
Swansea.
Jan. 10.

Dimensions of Electric and Magnetic Units

IF in a recent letter[1] Sir James Henderson uses the word 'dimensions' in its customary sense of relation to the units of length, mass and time, he is arousing false hopes by suggesting the possibility of a 'discovery' of the dimensions of μ_0 and K_0, for these dimensions, and not merely the numerical values of the quantities, are both completely arbitrary, depending upon the units of measurement which may be selected.

It has indeed been proved that $A^2/\mu_0 K_0 = c^2$ where A is the quantity appearing in Ampère's equation and c is the velocity of propagation of electromagnetic waves in a vacuum, but it still remains true that μ_0 and K_0 may each be separately given any values whatever. In some systems of units which have been adopted or discussed, for example, in the Gaussian system, separate values have been assigned to each; in other systems, as in the 'electrostatic' and in the 'electromagnetic' system, a value has been assigned to either K_0 or μ_0 and the other obtained from it by an arbitrary assumption such as $A = 1$, while other recently discussed systems are founded upon the adoption of two independent arbitrary assumptions from which the values of K_0 and μ_0 can be deduced, but for purposes of measurement, as distinguished from historical or more or less sentimental considerations, a system depends only upon the values of K_0 and μ_0 characteristic of it and not at all upon the methods by which these values were finally reached.

It is true that the electronic theory asserts that a magnet is not merely equivalent to but identical with a certain system of electrons in motion, but the argument that this identity necessarily requires the adoption of a system of units in which $\mu_0 = 1$ or in which mL must be dimensionally equal to iL^2 is altogether unsound.

Sir James may readily convince himself of this by the examination of the following simple example. The modern form of the electronic theory obviously suggests the existence of a 'natural' system of electromagnetic measurement in which the unit of electric quantity will be the electron and the unit of magnetic moment will be the Bohr magneton. The 'natural' unit of current will be such that a current i will involve the net passage of i electrons per unit of time and the 'natural' unit of quantity of magnetism will be such that two equal and opposite quantities m of magnetism separated by one unit of length will have a magnetic moment of m magnetons. On this system it is obvious that mL is dimensionally a numeric while the dimensions of iL^2 are L^2/T, and it is easily deducible that the dimensions of K_0 are T^2/ML^3 and of μ_0, T^2/ML. The numerical values of these quantities will, of course, depend upon the units of length, mass and time adopted.

It is scarcely necessary to remark that the theoretical charms of such a 'natural' system are totally eclipsed by its practical inconveniences.

L. R. WILBERFORCE.

University of Liverpool.
Jan. 21.

[1] NATURE, 135, 105; 1935.

Structure of the Caudal Fin of the Cod

WITH reference to Dr. Whitehouse's suggestion[1] that the caudal fin of the cod is of a normal homocercal type, may I state that I have just completed a study of the development of this fin, as a result of which I can affirm that, while it certainly preserves indications of its homocercal origin, it would be misleading to apply the term 'homocercal' to it in its present form.

Whereas in the homocercal fin practically the whole of the web is supported by morphologically ventral skeletal elements belonging to the hypochordal lobe, in the Gadoid fin the upper half of the web is supported by morphologically dorsal elements which arise in a dorsal fin fold, this growing back to fuse with a corresponding ventral fin fold and thus form the symmetrical web. Now Agassiz[2] long ago showed that, because the homocercal fin developed as an exaggeration of heterocercy, the terminal 'axial lobe' of the embryonic caudal fin (in which is included the tip of the notochord) forms a small dorsal lobe to the developing definitive fin. He was, however, unable to find this lobe in the cod, as can be well understood from my own observations, which show that it is suppressed between the developing dorsal and ventral components of the fin; it is here, in other words, medial rather than dorsal in position.

For this and other reasons the term 'pseudocaudal' appears to me to be the most satisfactory designation for the Gadoid fin. A full report and discussion of my results will be published elsewhere.

E. J. W. BARRINGTON.

Department of Zoology,
University College,
Nottingham.
Jan. 14.

[1] NATURE, 135, 70, January 12, 1935.
[2] *Proc. Amer. Acad.*, 13; 1877.

Evolution and Human Origins

My attention has been directed to the leading article in the issue of NATURE of January 26 in which criticisms are made on an address by me to the Victoria Institute recently. I have no desire to enter into further written controversy on the subject just at present, and you might probably be unable in any case to afford space for it in the pages of NATURE. If, however, no notice were taken of the objections urged, it might be considered that silence gave consent or that no answer is possible. I beg therefore by your courtesy to say that when, as seems probable, a new edition of the address is published, careful consideration will be given to the arguments in your leading article and such counter-arguments or replies presented as are necessary or possible. This will probably be a more convenient way of dealing with them than extending the controversy at the present time in the pages of your valued periodical.

Sidmouth, South Devon. AMBROSE FLEMING.
Feb. 3.

More Work for the R.S.P.C.A.

Much satisfaction must have been felt by lovers of the lower animals in reading the review in NATURE of February 2 (p. 164) of the work accomplished by the R.S.P.C.A. since its foundation in 1824. It encourages one to hope that the Society will delay no longer in pressing for prohibition of the cruel practice of docking the tails of horses.

It is not likely that any serious opposition would be offered to such legislation as may be necessary to render docking a penal offence. Something might be accomplished if horses mutilated and disfigured in this senseless manner were disqualified as prize-winners in the show ring; but that would not act as universal prohibition. One has but to watch horses thus mutilated when turned out to grass in summer to realise what they suffer from swarms of flies.

Fortunately, the practice of docking is not nearly so general as it used to be. During the Peninsular War, the Duke of Wellington required all cavalry chargers to be so treated in order that they might be distinguished from those in the French army. At the present time, however, the horses of British cavalry and those in all racing and most hunting establishments are not docked; but many farm horses and trotting cobs are still subject to the removal of some of their lower vertebræ.

HERBERT MAXWELL.

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Points from Foregoing Letters

The behaviour of liquid helium indicates that it exists in two forms, helium I and helium II. Their viscosities have been determined in Prof. E. F. Burton's laboratory at Toronto. It appears that when helium I, which is formed at 4·2° K, is further cooled, it becomes more viscous down to 2·3° K; at 2·2° K the liquid suddenly becomes more fluid as it changes into helium II.

Thin layers of carbonaceous fossil plants such as are present in coal, while opaque to ordinary light, allow the passage of infra-red radiation. Prof. John Walton submits photographs of a fossil plant taken in red and infra-red light, the latter showing marked internal structure.

It has been suggested that γ-radiation may be changed into positive electrons and vice versa. Dr. E. J. Williams finds that very thin lead foils (about 0·002 cm. thick), when irradiated with γ-rays from thorium C″, yield less than the calculated amount of secondary γ-rays. This he interprets as evidence that the positive electrons produced by the original γ-rays escape from the lead-foils before they are 'annihilated' and changed into the softer secondary γ-rays. The more penetrating γ-rays scattered by lead-foil are ascribed to γ-radiation from recoil electrons and to the annihilation of positive electrons before reaching the end of their journey.

Colchicine, the active substance from the seeds and corm of the meadow saffron, hitherto used in the treatment of gout, has been found by Dr. E. C. Amoroso to be effective in treating a spontaneous tumour in a dog. Dr. Amoroso also states that colchicine has effected the regression of tumours transplanted on mice.

Prof. B. C. P. Jansen supports Kuhn's claim that lactoflavine is identical with the originally described vitamin B_2, since both have identical effects on dogs and rats and are rendered inactive by exposure to sunlight. Prof. Jansen advocates the use of descriptive names instead of letters to indicate the various vitamins.

Prof. W. T. David has put forward the view that 'metastable molecules' account for the after-glow of gases following upon an explosive reaction. Dr. S. Steele recalls previous observations showing prolonged emission of infra-red radiation during the explosive reactions which take place in a combustion engine. He suggests that in an engine cylinder some metastable H_2O and CO_2 molecules may be formed.

The magnetic susceptibility of freshly melted water increases during the first twenty minutes and then falls to a constant level. This is explained by Dr. F. W. Gray and Mr. J. H. Cruickshank as due to the lag in the rearrangement of the water molecules (each molecule of H_2O is surrounded by four others in a more or less tetrahedron fashion; this arrangement is somewhat different in ice and in water). With heavy water a similar but less pronounced change with time is observed.

Dr. N. H. Hartshorne directs attention to the fact that transparent cellulose sheets behave towards light in a manner similar to that of crystals of mica, selenite and quartz, and in appropriate thicknesses may be substituted for them in making compensating plates and wedges for the polarising microscope.

Commenting on a letter from Sir James Henderson, Prof. Wilberforce shows that the accepted theory of the identity between magnetic phenomena and electronic motion does not establish, as a necessary deduction, the equations $\mu_0 = 1$, $K_0 = 1/c^2$, but on the contrary suggests a different 'natural' system of electromagnetic measurement attractive in theory but inconvenient in practice. The theory of dimensions has often been useful in deducing new physical laws.

Research Items

The Bones of Comenius. Very shortly after the death of the great Czech scholar, John Amos Comenius, in Holland in 1670, his fame, and even his last resting place were forgotten owing to disturbed conditions both in his native land and in Holland. In the earlier part of the nineteenth century his memory was revived; but notwithstanding an abortive attempt to fix the site of his grave in 1871, it was only after the close of the War that the Czechoslovakian Government was able to make arrangements with the Dutch authorities for the disinterment of his remains. This was made possible by the discovery of the register recording his interment in November 1670, not in the 'great church' of Naarden, as had previously been thought, but in the 'Walloon' church. This edifice, after a varied history, had long been occupied as a military barracks. The records showed that the body of Comenius had been deposited in a 'common' grave, in which two further interments had followed after considerable intervals. Largely owing to the interest of Mr. R. J. Vonka, of the Czechoslovakian Legation, and Dr. R. A. B. Oosterhuis, of Amsterdam, this grave was identified and one of the three skeletons provisionally identified by its position and general condition as that of the great scholar. The remains have been examined and measured in detail by Prof. A. J. P. van den Broek and Prof. J. Matiegka, who after a close comparison with portraits of Comenius and such information as is available, pronounce the identification to be in all probability well founded. The skull is hyperbrachycephalic (cephalic index of 89·71), hypsicephalic (vertical index 77·64), eurymetopic and mesoprosopic. The orbits are large and the nose thin. The form and dimensions of the skull, in fact, are such as are frequently encountered in Czechoslovakia. Among the more noteworthy features are the breadth of forehead and the fact that, notwithstanding the age of the subject at the time of death, the sutures of the skull had not closed. The discovery of the remains and their character and method of identification are described in *Anthropologica* (Académie Tchèque des Sciences et des Arts, Prague, IIme Classe, 1933, just received).

Prehistoric Rock Paintings in Abyssinia. The Abbé Breuil describes in *L'Anthropologie* (**44**, No. 5–6) a number of rock-paintings in the Harrar (Abyssinia) which he examined in 1933, when Dr. Paul Weinert was engaged in the excavation of the palæolithic cave of Porc-Epic at Diré-Daoua. One series of paintings was in the cave and a second was on a rock discovered by P. Azais at Sourré, sixty kilometres from Diré-Daoua. The cave of Porc-Epic is situated at the top of a cliff about 200 metres above the right bank of the River Diré-Daoua. Its deposits, separated by two thin layers of stalagmite, belong to mesolithic and upper palæolithic cultures analogous to those of Kenya and South Africa. In the upper and middle deposits, moustero-solutro-aurignacian implements are associated with geometrical microliths and a coarse pottery. On the right wall are a number of drawings, all more or less schematic, which are partly covered by deposits and, consequently, are older than the more recent stalagmite. The figures are highly conventionalised and, therefore, difficult of identification. Approximately, however, a list can be established which includes twenty human figures comparable to the most schematic of southern Spain, one elephant, one lion, two carnivores with pointed muzzle and ears, thirteen antelopes, three Bovidæ, etc. Nearly all are in bright red, but there are the remains of earlier figures in yellow ochre and a reddy-brown. The only remarkable figure is that of a stag, which is compared with a similar figure from Zara-Brouk (Addiet). The paintings on the rock at Sourré are of varied dating, distinguishable by the superpositions. They fall into eight classes which belong to two main periods, the five earlier stages being naturalistic, while of the later three, two are schematic phases united by a period of transition. There is a hunting scene, but all the remaining figures are of a pastoral character. They recall pre- and proto-dynastic Egypt. The identification of certain of the Bovidæ raises an interesting point bearing on the domestication of these animals.

Mitogenetic Radiation. The announcement, twelve years ago, by Gurwitsch, of the emission of radiations from rapidly growing tissues, occasioned no little interest and even surprise in biological circles, coming as it did from a histologist with so high a reputation. Many have been the attempts to repeat his observations, but the results of succeeding investigators have yielded positive and negative results as consistently as the tossing of a coin. Dr. J. B. Bateman has rendered valuable service to biological workers in carrying out a critical survey of the literature of the last dozen years dealing with this subject ("Mitogenetic Radiation", *Biol. Rev.*, **10**, 1, 42; 1935). The weight of the evidence tends slightly against the existence of such a phenomenon, and there is no ground at all to support the view that mitogenetic radiations, if they exist at all, have anything to do with ultra-violet radiation.

Statistics of Variations. Dr. Hans Günther has recently published a little book which serves as a short but useful introduction to the statistics of variation ("Die Variabilität der Organismen und ihre Normgrenzen". Pp. 132. Leipzig: Thieme, 1935). It is divided into fourteen sections, some of which may be mentioned as indicating its scope and character: the causes and categories of variation, statistical and biometrical methods, the conception of the norm and of the abnormal, the limits of variation and of the norm, various types of biological statistical analysis, and special methods for the comparison of variations, as between, for example, races, populations, the sexes, the right and left halves of the body and different stages of development. Various general questions regarding the nature and limits of variations are discussed.

Lamellibranchs and a Cruciform Muscle. Mr. Alastair Graham, following up his recent investigations of the cruciform muscle of certain Lamellibranchs (NATURE, Sept. 29, 1934, p. 500), has compared in detail the anatomy of five bivalves belonging to the Tellinacea, *Gari tellinella*, *Tellina crassa*, *Macoma balthica*, *Scrobicularia plana* and *Donax vittatus* together with *Cultellus pollucidus* as typical of the Solenidæ, and *Solecurtus scopula* and *S. chamosolen* as representing the *Solecurtidæ* (*Proc. Roy. Soc. Edin.*, **54** (2), No.

15, 1934). The result of this work, as was foreshadowed in the previous paper, shows that the Solecurtidæ should be classified with the Tellinacea rather than with the Solenidæ. The Solecurtidæ, in common with the Tellinacea, possess a cruciform muscle and in many other respects resemble that group, whereas in the Solenidæ the cruciform muscle is absent. The Solecurtidæ have, however, several features which are characteristic of the Solenidæ and there appears to be an undoubted relationship. As the author suggests, "the Solecurtidæ are to be regarded as a group of Lamellibranchs linking the Tellinacea with the Solenacea, but themselves retaining many more primitive features than do the Solenacea, and therefore falling themselves into the former group". The Solenidæ probably separated from the ancestral forms of the Solecurtidæ and the other Tellinacea before the evolution of a cruciform muscle had taken place, and since their separation have evolved along a well-defined line of their own. It is an interesting fact and one not easily explained that in the two estuarine species of the Tellinacea, *Macoma balthica* and *Scrobicularia plana*, the length of the intestine has become greatly elongated by coiling.

New Fresh-Water Mollusca. Mr. Alan Mozley has described several new fresh-water molluscs from northern Asia (*Smithsonian Miscellaneous Collections*, 92, No. 2; 1934). These were collected during a journey made in the years 1932 and 1933 through certain parts of Siberia and northern Kazakstan, the object of the expedition being to investigate the molluscan fauna of the region. The new species are all very like known British forms, a *Valvata*, a *Lymnaea*, a *Planorbis* and a *Physa*, and there are three new sub-species of *Lymnaea* (*Galba*) *palustris* described. The descriptions are of the shells alone, in some cases at least, only dead shells being obtained. *Valvata antiquilina*, n.sp., from Lake Khomotenoze, apparently lived at some former time when the water-level stood considerably higher than at present. *Limnaea palustris sandalensis*, n.subsp., comes from a small somewhat saline lake on the Steppe Sari Dala, south-west of Pavlodar, northern Kazakstan. Although distinguishable, these four sub-species resemble one another closely.

Tortrix Moth Pests of Fruit Trees. Messrs. G. L. Hey, of the Murphy Chemical Company, and F. J. D. Thomas, of the East Malling Research Station, have recently published an account of their investigations into the biology of *Cacœcia* (*Tortrix*) *podana*, Scop. (*J. Pomol. and Hort. Sci.*, 12, No. 4, pp. 293–310, December, 1934). The paper is the first of a series which is intended to include descriptions of a considerable number of Tortricidæ which infest fruit trees in Britain. *C. podana* was first described in 1854, and is now distributed throughout Europe, though it has not yet reached the United States. Characters of the larva in all its seven instars are described in the paper under review, and its depredations in each stage are considered. The pupa and mature insect receive shorter treatment. An extensive list of host plants, and a graphic description of damage done, give an idea of the economic significance of the pest. Methods of control depend upon the host plant. Larvæ can be removed from rhododendrons by spraying with lead arsenate, while this wash has little effect on the pest as it occurs on fruit trees, where the method of feeding is different. Traps placed around a bright light at night exterminate considerable numbers of mature moths, and several parasites of the larva are known.

A Wilt of Snapdragons. A serious disease of snapdragons recently occurred near Pretoria, South Africa. It was very swift in its action, for affected plants were often apparently healthy one day, and permanently wilted the next. The young roots and the base of the stem rotted and were frequently discoloured. The cause of this troublesome malady was investigated by Dr. Margaretha G. Mes ("A Wilt of Snapdragon, *Antirrhinum majus*, in South Africa", *S.A. J. Sci.*, 31, pp. 281–287, Nov. 1934). Two fungi were isolated from diseased tissues, one belonging to the genus *Phytophthora*, and the other to *Fusarium*, but infection experiments demonstrated that the former was the real pathogen. *Fusarium* was, however, responsible for discoloration of wilted plants. The disease-producing organism was identified as *Phytophthora pini*, var. *antirrhini*, but appears to have been classified also as a form of *P. cactorum*. Zoospores have been demonstrated, and the antheridia and oogonia are typical of the genus.

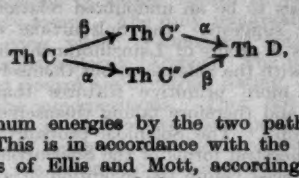
Vernalisation. Since the publication of Bulletin No. 9 on vernalisation by the Herbage Bureau, Aberystwyth, research on the subject has been proceeding rapidly in the U.S.S.R. The many conflicting statements that have appeared in the scientific and popular literature, however, have made it desirable that an authoritative account of the subject should be given, and the Bureau, with the collaboration of Prof. N. A. Maximov, of the Institute of Grain Husbandry, Saratov, U.S.S.R., has issued a further publication, "The Theoretical Significance of Vernalization" as Bulletin No. 16 in the Herbage Publication Series (Aberystwyth: Imp. Bur. Plant Genetics, 2*s*. 6*d*.). Since the discovery that by subjecting partially soaked seed to low temperatures, winter varieties of cereals could acquire the properties of spring varieties, that is, yield the same summer, the investigations have been extended to other types of plants. In the case of soy bean and cotton, vernalisation is effected by exposure of soaked seed to sufficiently high temperatures, after which fruit is formed successfully, even if subsequent temperatures would normally be too low. On the theoretical side, Lysenko's views are discussed in full, the most important of which seems to be that growth and development are essentially different phenomena. The plant, although in an apparently dormant condition, may be undergoing transitional developmental processes which can be profoundly affected by external conditions. Changes in the nature of the plant's composition are also brought about by vernalisation, both the colloidal properties of the protoplasm and the staining reaction of the embryonic tissue being altered after treatment. The first idea, that vernalisation actually accelerated plant development, is now regarded as needing modification. The truer interpretation seems to be that part of the growth period, which normally takes place in the field, can be transferred back to the early germination stages. The question as to whether or not vernalisation is an irreversible process is still a debatable point.

Recent Changes of Level in Japan. In the latest number of its *Bulletin* (12, 851–860; 1934), the Earthquake Research Institute has issued a valuable series of plates that illustrate recent changes of level

in Japan. During the last two years, a new line of precise levels has been carried out along the route bordering the east coast from near Tokyo northwards to Kamaisi and thence across the Main Island to Akita. Throughout the whole course of more than 350 miles, the crust since the last surveys (usually made between 1894 and 1900) has, with a few small exceptions, subsided. The principal movements are described by Messrs. T. Terada and N. Miyabe (*Tokyo Imp. Acad. Proc.*, **10**, 557–560; 1934). They consist of V-shaped depressions, one of which, about 100 miles north-north-east of Tokyo, has reached a depth of 32 in. in about thirty-six years. It lies in a line with the valley of the River Natui, a zone of frequent earthquakes. Another, of about 6 in. in thirty-four years, occurs on the cross-country route about 36 miles south-east of Akita. Some miles nearer the latter town, the curve of depression shows a marked break where it crosses the fault associated with the severe earthquake of March 15, 1914.

The Oxygen Afterglow. E. M. Stoddart (*Proc. Roy. Soc.*, A, Dec. 1, 1934) has investigated the afterglow obtained in oxygen, both in electrodeless high-frequency discharges and in discharges between aluminium electrodes. Pure oxygen showed no afterglow with electrodeless excitation, whether or not the surfaces of the tube were 'poisoned' with water vapour. This poisoning had been found by former workers to be necessary for the afterglow. No afterglow was produced by the addition of various other gases including nitrogen. With the electrode discharge, no afterglow was found with pure oxygen, but the addition of a little nitrogen produced a powerful afterglow. By connecting the tube with a trap cooled in a carbon dioxide freezing mixture, nitric oxide was shown to play a part in the afterglow. The afterglow gradually disappeared and nitrogen peroxide could be recovered from the cooled trap. No nitrogen peroxide was found in the electrodeless discharges. A spectral examination of the afterglow showed weak diffuse bands which are not oxygen bands. The author concludes that nitric oxide is formed by a process involving the metal electrodes in the tube, and that the emitter is the same as is present in the chemi-luminescence of nitric oxide and ozone.

The Limits of the Continuous β-Ray Spectrum. H. O. W. Richardson has recently discussed the low energy β-rays of radium E and W. J. Henderson has investigated the high energy limit of the β-rays from thorium C and C″ (*Proc. Roy. Soc.*, A, Dec. 1). The deposit of radium E was made on a thin aluminium foil and was placed in a Wilson expansion chamber. The energies of the electrons were deduced from their range, and in evaluating the distribution, corrections were made to allow for the loss of the ends of tracks by passing out of the illuminated field and in other ways. A number of the tracks observed are of secondary origin, but there is some evidence of a low energy group of β-rays from radium E. The paper by W. J. Henderson describes an analysis of fast γ-rays from thorium C and C″, using the semicircular magnetic focusing method with a pair of Geiger-Müller counters as a detector. The counters are mounted so that a β-ray passes through both counters, which are separated by a thin mica sheet. Only coincident discharges of the counters are recorded, and this method reduces by a factor of 25 the effect of the γ-rays from the source, which would otherwise mask the β-rays completely in spite of the lead screening. The distribution curves for the sources of thorium B + C + C″ slope steeply down to an end point at $2{\cdot}25 \times 10^6$ volts, while those for the sources of thorium C″ prepared pure by recoil have an end point at $1{\cdot}795 \times 10^6$ volts. Beyond these limits there is a slight background and a line at Hρ 10,280 known to arise from thorium C″. The experiments show that in the two alternative modes of decay of thorium C,



the maximum energies by the two paths balance exactly. This is in accordance with the theoretical suggestions of Ellis and Mott, according to which the maximum energy of the β-rays represents the difference in binding energies between the parent and product nuclei. The energy missing when a β-particle of lower energy is emitted has not yet been traced.

Magnetic Properties of Bivalent Samarium. Although bivalent samarium compounds have been reported as non-existent, P. W. Selwood (*J. Amer. Chem. Soc.*, **56**, 2392; 1934) has prepared the dibromide by heating the tribromide in hydrogen and has measured its magnetic susceptibility. This is found, at various temperatures between about 100° and 400° abs., to be almost the same as that of tervalent europium. This is the result which would be anticipated from the Sommerfeld-Kossel rule, which states that ions with equal numbers of electrons often have very similar properties. The arrangement of electrons in tervalent europium is (from the 4*f* shell outwards) $4f^6 5s^2 5p^6$. In bivalent samarium it is probably the 6*s* and one of the 5*d* electrons which are lost, $4f^6 5s^2 5p^6 5d(^2 6s)$. The remaining 5*d* electron, however, migrates to the 4*f* shell, thus producing a configuration identical with that of tervalent europium. The result is of added interest because both samarium and europium have anomalous temperature coefficients of magnetic susceptibility. A previously reported discrepancy in the susceptibilities of the compounds Sm_2O_3 and $SmBr_3$, of tervalent samarium, was not found.

Atomic Weight of Protactinium. A specimen of protactinium oxide which showed no impurities by the X-ray method has been prepared and utilised in the determination of the atomic weight of protactinium (A. V. Grosse, *J. Amer. Chem. Soc.*, **56**, 2501; 1934). Potassium protactinium fluoride, K_2PaF_7, crystallises in beautiful colourless needles, can be dried to constant weight, and can be reconverted into the oxide by treating with sulphuric acid, diluting, precipitating with ammonia and igniting. In two determinations, 0·091907 gm. and 0·070047 gm. of K_2PaF_7 gave, respectively, 0·056274 gm. and 0·042913 gm. of Pa_2O_5. The atomic weights of protactinium calculated are 230·4 and 230·8, the mean value, 230·6 or 231 ± 0·5, being in good agreement with Aston's mass-spectrograph results on actinium lead (AcD = 207). The compound $PaCl_5$, discovered by Grosse (*J. Amer. Chem. Soc.*, **56**, 2200; 1934), might be more suitable for the precision atomic weight determination planned, but larger quantities of protactinium (which is now available for use in ordinary chemical manipulations) are desirable.

Chlorophyll

THE green colouring matter of plants is a wax-like material of complex chemical structure to which the name chlorophyll was given by Pelletier and Caventou in 1817. It is insoluble in water but soluble in alcohol, ether and other organic solvents. Early investigations of chlorophyll which are important are those of Brewster and Stokes, on the absorption spectrum and fluorescence, and of Edward Schunck on the chemical side. Schunck studied particularly the action of acids on chlorophyll and found that important changes in its physical and chemical properties resulted. The first really fundamental investigations on the chemical structure of chlorophyll were those of Willstätter and his collaborators[1] which showed that there are two green pigments present in leaf-green, namely, chlorophyll-*a*, with the formula $C_{55}H_{72}O_5N_4Mg$, a bluish-black solid giving greenish-blue solutions; and chlorophyll-*b*, a greenish-black solid giving pure green solutions.

On hydrolysis, chlorophyll yields an alcohol, phytol, $C_{20}H_{40}O$, which has been synthesised, and a complex containing four pyrrole nuclei, the composition of which has been determined by examining the decomposition products phytochlorin-*e* from chlorophyll-*a* and phytorhodin-*g* from chlorophyll-*b*, these two substances being usually called now chlorin-*e* and rhodin-*g*. By the action of acids on chlorophyll, a product free from magnesium, called phæophytin, is obtained, separable into two components, *a* and *b*. This in its turn, on treatment with hydrochloric acid, yields two phæophorbides, *a* and *b*. By the further degradation of chlorophyll and its derivatives many products are obtained, known as porphyrins.

Since Willstätter's pioneer work, the investigation of chlorophyll and its derivates has been continued mainly by Hans Fischer[2], who has carried out some important syntheses, and by J. B. Conant[3], and their collaborators. The results obtained by these two groups of investigators sometimes differ in points of detail[4]. The present article has the object merely of recording some recent new work on the subject, the present position of which must be sought in the sources given in the references.

A method which has been used in attempts to determine the relations between different substances is hydrogenation. Dietz and Werner[5] now propose to discard this method as leading to very puzzling results difficult to reconcile with other reactions of the substances. Thus, two porphyrins which appear to be isomeric, rhodoporphyrin and isorhodoporphyrin, differ by 0·8–1·2 molecules of hydrogen absorbed, whilst they are interconvertible in 50 per cent sulphuric acid at room temperature. Transformation also occurs slowly in cold concentrated hydrochloric acid and more rapidly in glacial acetic acid with dry hydrogen bromide. If the difference in hydrogen absorption is regarded as indicating a difference in hydrogen content, the acid transformations must be reductions, which seems very unlikely.

The hydrogenation results show only a small difference between the chlorins and true porphyrins. If these results are accepted, chlorophyll and the chlorins are to be regarded as dihydroisoporphyrins in basic structure and also isomeric with true porphyrins, as Fischer postulates. The American workers, however, while continuing to assume that the fundamental nucleus of chlorophyll and the chlorins is that of a dihydroisoporphyrin, postulate that it is also that of a dihydroporphyrin, these being of an equal state of hydrogenation.

A very interesting new method of attack has now been developed by Conant, Chow and Dietz[6], namely the potentiometric titration in acetic acid solution of the basic groups in chlorophyll derivatives. The chlorophyll nucleus and those of its derivatives contain four pyrrole or modified pyrrole rings. An important problem in connexion with the fine structure of the nucleus is the determination of the relative basicities of the four pyrrole nitrogen atoms, which add together to determine the basic character of the whole molecule. Willstätter had utilised the variation in basicity in the chlorophyll series in the method of acid fractionation, which made possible the separation of chlorophyll derivatives in solution, and had also obtained qualitative evidence of the greater basicity of two of the nitrogen atoms by the isolation of dihydrochlorides.

Conant and his collaborators have now supplied quantitative evidence on this problem by a series of potentiometric titrations in glacial acetic acid using a chloranil electrode and perchloric acid as titrating agent, a method which had previously been studied[7]. This electrode makes use of an oxidation-reduction system similar to that in the quinhydrone electrode. Chloranil and its reduction product provide the system in equilibrium with hydrion:

$$C_6Cl_4O_2 + 2H^+ \rightleftharpoons C_6Cl_4(OH)_2 + 2\oplus,$$

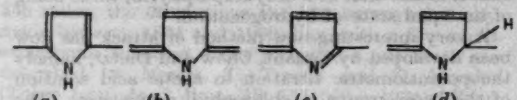
and a *p*H scale can thus be derived from it. When the solvent is glacial acetic acid, this *p*H scale will not, of course, be related directly to the standard hydrion activity as defined for aqueous solutions, but it may be defined in terms of an acidity function by a method discussed by the authors. For comparative purposes this is a secondary consideration, and the values of *p*H in acetic acid may be calculated by a formula similar to that used for the quinhydrone electrode in aqueous solutions, a particular value being taken for the standard potential. If the reaction between chlorophyll base (B) and acid proton (H^+) is formulated as $B+H^+ \rightleftharpoons BH^+$, the value of pK^1, the dissociation constant of the chlorophyll base, will then be given by:

$$pK^1 = p\mathrm{H} + \log (B\mathrm{H}^+)/(B)$$

in which all symbols refer to the acetic acid solutions. The ionic strength of the solution (which influences the activity coefficients of the solutes) was kept constant at $\mu = 0{\cdot}2$ by adding the required amounts of the neutral salt trimethylammonium perchlorate. The values of pK^1_1, pK^1_2 and pK^1_3, for the dissociation of the first, second and third basic groups, corresponding to titration mid-points for each range, were read directly from the titration curves at added aliquots of 0·5, 1·5 and 2·5 mols of titrating agent, in accordance with the usual *approximate* theory for calculating *pK* from the *p*H titration values.

In this way, the values of pK^1 for a series of simple nitrogen compounds (positively and negatively substituted pyrroles, a dipyrrylmethane, two *N*-methyl methanes and a methylethylmaleic imide) were first determined. These are all about $-2{\cdot}3 \pm 0{\cdot}3$, indicating that the pyrrole group is a very weak base. If pyrrole is regarded as a substituted ammonia, the two α, β-unsaturated linkages appear to control the

diminution in basic character of the ammonia nitrogen. All the chlorophyll derivatives examined contain at least one and possibly two of the very weakly basic groups (*a*) or (*b*):



(*a*) pyrrole (*b*) isopyrrole (*c*) pyrrolenine (*d*) hydropyrrole

and they gave pK_2^1 values of $-1{\cdot}9$ to $-2{\cdot}4$.

With very few exceptions, all these compounds also contain one rather strongly basic group with a pK_1^1 value of $+1{\cdot}8$ to $+2{\cdot}3$, which, as titrations of two methenes indicated, was probably the oxidised pyrrole or pyrrolenine ring (*c*), having one α, β-unsaturated linkage and a tertiary nitrogen atom. Pyridine has also a pK^1 value of $+2{\cdot}93$, which is the lower limit of basic strength in the glacial acetic acid system. This system gives satisfactory results for basic strengths of compounds such as urea, which have pK in water of about zero, and compounds so weakly basic (for example, acetanilide and acetamide) that they cannot be measured in water.

The porphyrins stand out as a group from all other chlorophyll derivatives in containing *two* relatively strong basic groups, of average pK^1 of $+2{\cdot}5$. The chlorins are differentiated from the porphyrins in having only *one* relatively strongly basic group, with $pK^1 = +2{\cdot}1$, and one group intermediate in basicity between the pyrrole and pyrrolenine groups, possibly an oxidation or reduction product of the latter in which the character of the nitrogen atom is changed. The basicity of this group is influenced by substituent groups and is comparable with the basicity of urea and acetoxime. This result leads to a correction of a previous formula for chlorin *f*, which is now supposed to contain a hydropyrrole nucleus (*d*) in place of one of the two pyrrolenine rings previously assumed by Conant.

The true chlorophyll-*a* compounds, the phæophorbides, are found to contain one relatively strongly basic and one very weakly basic group, as in the chlorins. The intermediate group, however, is less basic than in the chlorins; but whether this difference is significant of a radically different structure is difficult to say. In the *b* series, rhodin-*l* is the simplest compound and corresponds with chlorin-*f* in the *a* series. The two basic groups in rhodin-*l* are weaker than in the *a* series, but rhodin-*g* is very similar to chlorin-*e*. Methyl phæophorbide-*b* is markedly different from the *a* compound in the relatively strongly basic group. It appears that the extra oxygen atom in the *b* series affects the basicity of all the compounds, which would be unlikely if it were in the side chain of the propionic acid group, as postulated by Fischer.

The interpretation of the results of the new potentiometric titration experiments is still incomplete and rather tentative; but it is clear that the method promises to throw light on the structure of compounds containing basic groups, and its extension from the chlorophylls and porphyrins into other fields is obvious.

[1] Summarised in R. Willstätter and A. Stoll, "Untersuchungen über Chlorophyll", Berlin, 1913.
[2] Pedler Lecture, *J. Chem. Soc.*, 245; 1934.
[3] Many papers in *J. Amer. Chem. Soc.*, 1929 to date.
[4] Critical summary of the literature by K. F. Armstrong, *Chemistry and Industry*, 809; 1933.
[5] E. M. Dietz and T. H. Werner, *J. Amer. Chem. Soc.*, **56**, 2180; 1934.
[6] J. B. Conant, B. F. Chow and E. M. Dietz, *J. Amer. Chem. Soc.*, **56**, 2185; 1934.
[7] J. B. Conant and T. H. Werner, *J. Amer. Chem. Soc.*, **52**, 4436; 1930; J. B. Conant and B. F. Chow, *ibid.*, **55**, 3745; 1933.

Fuel Research in Great Britain*

THE work of the Fuel Research Board touches many aspects of the technology of fuel, and the annual report for the year ending March 1934 therefore provides a useful review of the problems before the coal and other fuel industries.

In the first place, the report emphasises the steady accumulation of information by the survey of the coalfields of Great Britain, the value of which becomes increasingly evident as the demands on the properties of fuel become more exacting.

Reference is made to the fall in demand for large lump coal in recent years. Formerly, collieries made great efforts to avoid breaking coal because the consumer was prepared to pay, for size, a premium which was disproportionate to the calorific value of the coal itself. Actually the consumer paid his premium for a fuel the cleanness of which was visible to the eye. Now more than 77 million tons of coal is washed and its quality can be guaranteed, irrespective of size. Industrial fuel is nearly always wanted in small pieces, especially when firing is automatic. The modern house has little room for storage, and the householder wishes to avoid the trouble and dirt of breaking coal. One can foresee a time when the large lumps will become unsaleable, and already some collieries are seeking the best and most efficient manner of breaking down lump coal without the undue formation of dust. Many difficult problems arise when coals are broken, such as the best treatment of wash water containing dust, and the staff of the Fuel Research Board is engaged on their examination.

A section of the report deals with the liquid fuels from coal. A small fraction of the needs of Great Britain is covered by the by-products of coal carbonisation, that is, benzole and coal tar oils. Most of the liquid fuel is imported from distant parts where Nature has provided a bounteous though, from our point of view, ill-placed supply of oil. The geographical distribution of petroleum provides food for speculation as to what the distribution of man might have been had he known of the existence of the oil earlier, or had understood how to obtain, control and distribute the natural gas which accompanies oil in such abundance. Industries might have been very differently situated, and it is improbable that men would have toiled against the hazards of coal-getting if such an ideal fuel as methane were available without effort. Even as it is, Governments all over the world are exerting themselves to turn solid into liquid fuels by processes which are technically speaking heroic but, judged by ordinary standards, uneconomic. The studies of the Fuel

* Department of Scientific and Industrial Research. Report of the Fuel Research Board for the Year ended 31st March 1934, with Report of the Director of Fuel Research. Pp. vii+178. (London: H.M. Stationery Office, 1934.) 3s. net.

Research Board on this problem are interesting because so much of the experience in this field is in private hands.

It is shown that a large proportion of coal tars—indeed practically the whole of a low temperature tar—can be hydrogenated to first-class motor spirit, and a larger plant for this purpose is being erected. As regards the hydrogenation of coal itself, the influence of minor inorganic ingredients is receiving special attention. Lubricants are not less important than the fuels and it is found that although some are obtainable from coal products, they are not yet suitable for common use.

Considerable attention is being given to the use of pulverised fuel at sea. The 'grid' burner for pulverised fuel devised at the Fuel Research Station is now in commercial use. Favourable reports are received of the use of pulverised fuel with this burner, and it is claimed to be, in general operation, equal to oil firing in similar furnaces, but more economical both thermally and in cost.

A new feature is the appointment of a 'scientific panel' of academic chemists, who are to engage upon more academic investigation bearing on fuel processes. The Board is also giving financial support, but unfortunately on a scale reduced in 1931, to other investigations in university laboratories. H. J. H.

University and Educational Intelligence

CAMBRIDGE.—R. I. N. Greaves, of Clare College, has been appointed University demonstrator in pathology. Dr. J. D. Boyd, of the Queen's University, Belfast, and R. S. Handley, of Gonville and Caius College, have been appointed University demonstrators in anatomy.

THE University Catholic Societies in Great Britain, twenty-three in number, are federated in an organisation which is linked with other national student federations through "Pax Romana", an international secretariat to which papal recognition was, for the first time, formally accorded last April. The British federation has marked its sense of the importance of this event by publishing in its Year Book for 1934–35 somewhat detailed expositions of its aims and policy and those of Pax Romana, and a report on a pilgrimage to Rome of a party of 130 of its members. Its general aim is to assist in the "Catholic education of persons of academic standing", the process being developed *pari passu* with secular studies and comprising, in addition to religious exercises, Catholic philosophy, Catholic social principles, Catholic missionary efforts and Catholic "action in the world at large". Further light on its outlook is to be found in the report, published in the Year Book, of the proceedings of its annual meeting held at Edinburgh on June 29–July 2, 1934. Here the general theme of the discussions was "The Catholic Approach to Knowledge", the chief contributions being papers read by Prof. G. Temple of King's College, London, on "Man and Knowledge" in which the supreme importance of metaphysics was urged, by Prof. E. T. Whittaker on "Man and the Universe" and by Mr. J. A. Lauwerys, of the University of London Institute of Education, on "Man and Life", in which he stresses, as in his book on "Education and Biology", a vitalistic point of view and the importance of teleology.

Science News a Century Ago

Social Economics

On February 16, 1835, a paper by Lieut.-Col. Sykes was read to the Statistical Society entitled "On the Increase of Wealth and Expenditure in the Various Classes of Society, as indicated by the Returns made to the Tax Office, by Exports, Imports, and Savings Banks". The classes included in this review were the gentry, the trading and manufacturing bodies and the depositors in savings banks, and the author gave some interesting particulars regarding the increase of capital employed in various articles of trade and luxury. The increase in population of England, from 1821 to 1831, he said, had been 11·3 per cent (from 11,760,555 to 13,091,005) and for the entire population of Great Britain and Ireland the increase had been somewhat more, from 21,726,924 to 24,306,719. In the same period, the poor rates had risen from £6,674,083 to £8,316,617. The total number of depositors in the savings banks was 475,155 and the amount deposited £15,715,111. In concluding his paper, Col. Sykes said it had been his object to offer a practical illustration of the facilities the Statistical Society afforded to everyone to collate facts with the view of showing the actual state and past changes in the condition of society.

Civil List Pensions for Men of Science

The recognition by the Government a century ago of eminent men of science led in the first place to the conferment of several knighthoods. It was next resolved to grant Civil List pensions. The first of these was awarded to Airy, then thirty-four years of age. On February 17, 1835, Sir Robert Peel wrote to Airy and in the course of his letter he said: "I consider you to have the first claim on the Royal Favour which Eminence in those high Pursuits to which your life is devoted, can give, and I fear that the Emoluments attached to your appointment in the University of Cambridge are hardly sufficient to relieve you from anxiety as to the Future on account of those in whose welfare you are deeply interested."

"The state of the Civil List would enable me to advise the King to grant a pension of three hundred pounds per annum, and if the offer be acceptable to you the Pension shall be granted either to Mrs. Airy or yourself as you may prefer."

"I beg you distinctly to understand that your acquiescence in this Proposal, will impose upon you no obligation personal or political in the slightest degree. . . ."

Airy replied from the Observatory, Cambridge, on the following day, thanking Sir Robert Peel, and asking that the pension might be settled on Mrs. Airy. Peel replied on February 19, saying: "I will give immediate directions for the preparation of the warrant settling the Pension on Mrs. Airy. . . . I assure you I never gave an official order which was accompanied with more satisfaction to myself than this."

Wheatstone on Musical Sounds

At King's College, London, on February 17, 1835, Wheatstone delivered an introductory lecture on musical sounds. A report of the lecture appeared in the *Athenæum* of February 21, 1835. After showing how the oscillations of bells and string and wind instruments could be made visible, Wheatstone went on

to the consideration of that modification of sound which constitutes its pitch, and showed that it depends on the frequency of vibration; he also explained the several modes by which this frequency could be estimated. He made experiments with Robison's stop-cock and Cagniard de la Tour's syren, and referred to the standard of pitch proposed by Chladni. He next dealt with the various experiments made with the view of determining the limits of audibility, with respect to the human ear, dealing particularly with those of Wollaston and Savart, and explained the origin and formation of musical scales. He concluded his lecture with an exhibition of Trevelyan's experiments on the vibration of heated plates, and a mode of producing sounds by an electromagnetic apparatus.

One of Faraday's Unsuccessful Researches

At intervals throughout the year 1835, Faraday worked on the preparation of fluorine. He had completed the long series of experiments by which he had laid the foundations of electro-chemistry, and had not yet begun his researches on electrostatics. In the course of his determinations of electrochemical equivalents, he had found that fused salts as well as aqueous solutions could be electrolysed, in certain cases with the separation of the elements in a free state; and he proposed now to apply the method of electrolysis to fluorides in the hope of devising a method of producing fluorine. Thus on February 19, 1835, the "Diary" records the construction of an electrolytic retort, of platinum, with electrodes of the same metal, in which experiments were begun on the electrolysis of fused lead fluoride. This research was unsuccessful as regards the production of fluorine. It came between two of his great periods of discovery, and was given up at the end of 1835, so that he might begin the electrostatic experiments with the great cube in the Royal Institution lecture theatre. It is of interest as an investigation which is described at some length in the "Diary", but of which no record appears in his published work.

The South Magnetic Pole

At a meeting of the Royal Society on February 19, 1835, E. Rudge read a paper "On the Probable Position of the South Magnetic Pole". The recent discovery of the site of the North Magnetic Pole, which had resulted from the experiments of Capt. James Ross, had suggested to the author the inquiry whether any similar indications of an approach to the South Magnetic Pole could be gathered from any observations then on record. With this view he gave a table of the observations made by Tasman in 1642 and 1643, during his voyage of discovery in the Southern Ocean, extracted from his journal. From this it appeared that Tasman on one occasion noticed the continual agitation of the horizontal needle, in south latitude 42° 25′ and longitude from Paris 160°. On the presumption that the South Magnetic Pole, said the author, was at that time near this spot, and that it had since been retrograding towards the east, he conjectured that it would now be found in or about the 43rd parallel of south latitude; and to the south-east of the Island of Madagascar, a situation extremely convenient for ascertaining its exact position, which he considered an object of great theoretical as well as practical importance.

Societies and Academies

LONDON

Royal Society, February 7. E. N. DA C. ANDRADE and P. J. HUTCHINGS: Mechanical behaviour of single crystals of mercury. In the mercury crystal the rhombohedral faces are glide planes, and the short diagonal is the glide direction. The crystal twins under strain on a plane through the long diagonals of two opposite faces acting as glide planes. In simple glide, twinning takes place when the twinning plane makes an angle of 45° with the axis of the wire. The rhombohedral face and the hexagonal basal plane are equally close-packed, but the former contains a much more closely packed line than does the latter. Double and triple glide can take place. Hardening on one set of glide planes hardens the whole crystal. The critical shear stress at −43° C. is 9·3 gm. wt. per sq. mm. E. N. DA C. ANDRADE and J. C. MARTINDALE: Structure and physical properties of thin films of metal on solid surfaces. The films were prepared by cathodic sputtering under carefully controlled conditions, with a water-cooled anode. The films obtained were uniform, and appear to be amorphous with all types of microscopic examination. When they are maintained at a temperature of about 230° for silver, and somewhat higher for gold, the first stage of crystallisation takes place, which consists in the formation of birefringement aggregates, of the order of 1 μ across, showing the spherulitic figure in polarised light. Prolonged heating at a somewhat higher temperature leads to rapid growth of the particles, which eventually become well-formed cubic crystals, all arranged with the (111) faces parallel to the supporting surface. The first aggregates are formed by the movement of the upper layers of the films, which are about 50 atoms thick, the further growth of the crystals being accompanied by the formation of areas from which the metal has retreated, leaving a thinner film. Crystallisation in such thinner films does not take place until a much higher temperature is reached than that required for the thicker films. M. BORN: On the theory of optical activity. This paper contains a detailed development of the theory of rotatory power given by the author in 1915. The molecule is considered as consisting of a set of isotropic oscillators coupled by Coulomb forces. The interaction is calculated by the perturbation method. The resultant formula is rather complicated but can be simplified very much for special cases. A molecule consisting of two equal pairs of oscillators perpendicular to one another and to their central line is worked out in detail; it gives the angle of rotation of the expected order of magnitude.

DUBLIN

Royal Dublin Society, December 12. KENNETH C. BAILEY: Thermal decomposition of hydrogen peroxide in presence of glass wool and copper sulphate. Hydrogen peroxide decomposes very slowly in the absence of suitable solid surfaces, even in markedly alkaline solution. In presence of glass wool, the decomposition is probably complex, and approximately correct results are obtained by using the equation $v = 15[H_2O_2]\,[OH'] + 7 \times 10^{-5}\,[H_2O_2]$, the *amount* of glass wool present having very little influence on the velocity, although the stopping of the reaction in absence of solid surfaces suggests that both first and second order reactions are probably

heterogeneous. In presence of glass wool on the surface of which copper has been adsorbed, the reaction is of zero order, and probably takes place in two stages, a peroxide of copper acting as intermediate compound. It seems certain that this reaction follows an entirely different course from that on the surface of glass wool alone, copper ions in solution having little or no effect. J. LYONS: The influence of physical and mechanical treatment on the firmness of butter. When the cream is cooled to a low temperature immediately after pasteurisation, it gives butter which is considerably firmer than cream which is not so cooled. Pasteurising cream at unnecessarily high temperatures reduces the firmness. The fat content of the cream used for churning and the moisture content of the butter and size of the fat globules in the cream appear to have little influence on the firmness. The firmness of butter does not appear to be improved by holding it at a low temperature over a long period.

PARIS

Academy of Sciences, January 2 (*C.R.*, **200**, pp. 1–100). JULES DRACH: The logical integration of equations of dynamics with two variables. Conservative forces. Cubical integrals. Movements in the plane. LOUIS BLARINGHEM: The acclimatisation and degenerescence of varieties of brewing barley, *Hordeum distichum*. Discussion of the conditions necessary for the maintenance of the stability of hybrid barley. MAURICE GIGNOUX and LÉON MORET: The tectonic of the external border of the zone of the Flysch of Embrunais, between the Brac and the Durance (Piolit and Autanes massifs, Haute-Alpes). S. JANCZEWSKI: The complex equations of Fredholm with uniform nuclei. C. POPOVICI: The kinematic equilibrium. ANDRÉ WEIL: Almost periodic functions. A. DINGHAS: Remarks on two theorems of the theory of functions. JULIUS WOLFF: The conservation of the angles in the conformal representation of a domain in the neighbourhood of a boundary point. FERNAND HOLWECK: Improvements in the elastic pendulum. Recent gravimetric linkages between the reference station of the French network and that of neighbouring countries. F. PRUNIER: An experiment of Sagnac with a flux of electrons. P. LANGEVIN: Remarks on the preceding communication. ALBERT ARNULF: The resolving power of optical instruments as a function of the acuteness of vision. N. THON: The capacity of polarised mercury at very low frequencies. After studying and eliminating certain sources of error, the author finds, contrary to the experiments of Erdey-Gruz and Kromey, that there is complete agreement between the capacities calculated starting with the cathode and anode polarisation. CHARLES HAENNY: The variations of the magnetic double refraction of cerous salts in solution. RAYMOND LAUTIÉ: Latent heat of vaporisation and characteristic temperature. ARNALDO PERES DE CARVALHO: Contribution to the study of phototropy. Three new phototropic bodies. MARCEL CHÂTELET: Some reactions of cobalt sulphate dissolved in glycerol. MAURICE DODÉ: The study of the decomposition products of ammonium perchlorate. At temperatures less than 300° C., chlorine, oxygen, water and nitrous oxide are the main products of decomposition: at higher temperatures the reaction becomes explosive and nitric oxide appears in the place of nitrous oxide. JEAN CALVET: The annealing of pure aluminium and its possible utilisation as a criterion of the purity of the metal. The samples studied ranged between 99·96 and 99·9986 per cent of aluminium, and the differences between the velocities of annealing are so large that a study of annealing after rolling into sheets forms a very sensitive test of the purity of the metal. JULES GARRIDO: The crystalline structure of manganite. STOYAN PAVLOVITCH: The action of heat on some natural oxides of manganese. A. KAZMITCHEFF: The tectonic structure of the Cannes-Antibes region (Alpes Maritimes). PAUL FALLOT and LOUIS DONCIEUX: The age of the Flysch of the periphery of the limestone chain of the Rif. F. LINK: The density of the upper atmosphere calculated from twilight phenomena. The theory of meteors of Lindemann and Dobson led to higher densities for the upper atmosphere than those generally accepted. The author, using a totally different method, confirms these results. JOSEPH DEVAUX: Study of the albedo of snow in the infrared spectrum. Starting with the band due to the water vapour in the air, melting coarse grained snow absorbs practically the whole of the solar radiation. R. BUREAU: The foci of atmospherics and their localisation. MLLE. COLETTE GAUTHIER: Singular reaction of a bean (*Phaseolus Mungo*) to a lesion of the seed. EMILE MIÈGE: The variations of the characters of seeds of elementary species of *Hordeum distichum*. RENÉ HAZARD: The action of sparteine on the inversion of the hypertensive effects of adrenaline by three phenoxyethylamines. PAUL WINTREBERT: The irregular mitoses of the vitelline merocytes in the course of embryogenesis of selacians (*Scylliorhinus canicula*). MAURICE PIETTRE, AUGUSTIN BOUTARIC and MME. MADELEINE ROY: The study of some proteins in aqueous solution. GEORGES CRUT: The comparative study of the action of hydrogen ions and of thrombase on the coagulation of fibrinogen. J. VELLARD and M. MIGUELOTE-VIANNA: Blood modification in cancer subjects treated with snake poison. Study of the effects produced by small repeated doses of snake poison. The necessity of extreme caution is emphasised.

BRUSSELS

Royal Academy (*Bull. Classe Sci.*, No. 11). TH. DE DONDER: The system adjoint to a linear system of partial derivatives of several unknown functions (2). CL. SERVAIS: Geometry of the tetrahedron (12). LUCIEN GODEAUX: Second order involutions of space. A second order involution produced by a birational transformation of the seventh order, having a single fundamental curve of the first kind of order eight and genus five, first investigated by Montesano, is considered. TH. DE DONDER: Vortical gravific. A gravific theory is developed in which the potentials $g^{\alpha}_{\alpha\beta}$ are antisymmetrical. This *vortical* gravific completes the classical gravific constructed from symmetrical potentials, $g_{\alpha\beta}$, and furnishes a unitary theory of the electromagnetic field. MARCEL WINANTS: Solution of a problem in limits concerning the equation $\frac{\delta^2 z}{\delta x^2} = \frac{\delta z}{\delta y}$. M. KOURENSKY: Integration of systems of partial differential equations of the first order containing two unknown functions of three independent variables. YVONNE DUPONT: Electromagnetic couples and angular momenta in the gravific of Th. De Donder. (2) The antisymmetrical electromagnetic tensor is expressed in terms of the polarisation tensor and of the two electromagnetic potentials generalised by J. Géhéniau. GEORGETTE

SCHOULES: Application of generalised statistical mechanics to the calculation of the entropy of gases with rigid molecules. De Donder's generalised statistical mechanics is used to calculate the entropy of a gas of rigid molecules. With the classical statistics the formulæ of Ehrenfest and Trkal are obtained. The Bose-Einstein and Fermi-Dirac statistics are also employed and a general formula for the entropy in terms of the energy is deduced. M. BERTRAND: Mechanism of pulmonary ventilation in the turtles. The triphasism of the respiratory movements is caused by the occlusion of the glottis. The expiration which precedes the central pause is purely passive. Z. M. BACQ: Physiological observations on the heart, the muscles and the nervous system of an ascidian (*Ciona intestinalis*). The chronotropism of the heart of *Ciona intestinalis* is not modified by non-toxic doses of adrenaline, acetylcholine or the ions of potassium, calcium and barium.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Sunday, February 17

BRITISH MUSEUM (NATURAL HISTORY), at 3 and 4.30.—Dr. Isabella Gordon: "Deep-sea Crustacea".*

Monday, February 18

BRITISH MUSEUM (NATURAL HISTORY), at 11.30.—A. C. Townsend: "The Linnæus Collection in the Library".*

CHADWICK PUBLIC LECTURE, at 5.15—(at the Royal Society of Tropical Medicine and Hygiene, Mansion House, 26 Portland Place, W.1).—Dr. William A. Robson: "A Hundred Years of Public Health Administration".*

UNIVERSITY OF LEEDS, at 5.15.—Prof. B. Melvill Jones: "The Stalling of Aeroplanes".*

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Major R. E. Cheesman: "The Islands of Lake Tana".

Tuesday, February 19

ROYAL HORTICULTURAL SOCIETY, at 3.—Annual Meeting. Lord Aberconway: Presidential Address.

Wednesday, February 20

ROYAL SOCIETY OF ARTS.—Lieut.-Col. J. D. Restler: "Water Supplies from Underground Sources".

INSTITUTE OF PHYSICS, at 8—(at the Science Museum, South Kensington). Informal discussion on "Modern Magnetic Materials and their Application".

Thursday, February 21

ROYAL SOCIETY, at 4.30.—Dr. F. W. Aston: "The Isotopic Constitution and Atomic Weights of Hafnium, Thorium, Rhodium, Titanium, Zirconium, Calcium, Gallium, Silver, Carbon, Nickel, Cadmium, Iron and Indium". J. M. Stagg: "The Diurnal Variation of Magnetic Disturbances in High Latitudes".

Friday, February 22

INSTITUTION OF CHEMICAL ENGINEERS, at 11—(at the Hotel Victoria, Northumberland Avenue, London, W.C.2).—Thirteenth Annual Corporate Meeting.
W. Macnab: "Chemical Engineering in Explosives Manufacture" (Presidential Address).

INSTITUTION OF MECHANICAL ENGINEERS, at 5.30.—Annual General Meeting.
Dr. H. E. Merritt: "Worm Gear Performance".

INSTITUTION OF PROFESSIONAL CIVIL SERVANTS, at 5.30—(at the Royal Society of Arts).—R. A. Watson Watt: "The Cathode Ray Oscillograph".*

ROYAL INSTITUTION, at 9.—Prof. A. O. Rankine: "Some Experiments in Gravitation and Magnetism".

Official Publications Received

GREAT BRITAIN AND IRELAND

Department of Scientific and Industrial Research. Report for the Year 1933–34. (Cmd. 4787.) Pp. iv+192. (London: H.M. Stationery Office.) 3s. net.

Department of Scientific and Industrial Research. Report of Test by the Director of Fuel Research on the Plant of the British Coal Distillation Company, Ltd., at Newbold, Leicestershire, Test carried out 11th to 25th March 1933. Pp. iv+29. (London: H.M. Stationery Office.) 9d. net.

Report on the Third Mycological Conference, 1934. Pp. 32. (Kew: Imperial Mycological Institute.) 2s. net.

OTHER COUNTRIES

Denkschriften des Schweizerischen Naturforschenden Gesellschaft. Band 69, Abh. 2: Die Mittlere Kreide in den helvetischen Alpen von Rheintal und Vorarlberg und das Problem der Kondensation. Von Arnold Heim und Otto Seitz, unter Mitarbeit im Felde von Siegfried Fussenegger. Pp. xl+185–310+8 plates. (Zürich: Gebrüder Fretz A.G.)

Publications of the Dominion Observatory, Ottawa. Vol. 12: Bibliography of Seismology. No. 3: July, August, September, 1934. By Ernest A. Hodgson. Pp. 47–64. (Ottawa: King's Printer.) 25 cents.

Mysore Geological Department. Bulletin No. 15: Cummingtonite in the Limestones of Kudurekanave (Mysore State). By B. Rama Rao. Pp. iv+36+7 plates. (Bangalore: Government Press.) 1 rupee.

The Coconut Research Scheme (Ceylon). Bulletin No. 1: Report on the Soap Industry in Ceylon. By Dr. R. Child. Pp. iv+45. (Lunuwila: Coconut Research Scheme.)

League of Nations: Health Organisation: Permanent Commission on Biological Standardisation. Report of the Second International Conference on Vitamin Standardisation (London, June 12th to 14th, 1934). Pp. 13. (Geneva: League of Nations.)

A Study of the Life History and Food Habits of Mule Deer in California: a Contribution from the Wildlife Division, United States National Park Service. By Joseph S. Dixon. (Reprint from California Fish and Game, Vol. 20, Nos. 3 and 4.) Pp. 146. (Sacramento: California State Printing Office.) 25 cents.

Baltische Geodätische Kommission. Sonderveröffentlichung No. 3: Bestimmung der Längenunterschiede der Landeszentralen im Jahre 1929, 2: Die Berechnung der Längendifferenzen der Landeszentralen, von F. Pavel; Die Berechnung der Längendifferenzen der Landeszentralen, von Ilmari Bonsdorff. Pp. 49+91. (Helsinki.)

Proceedings of the American Academy of Arts and Sciences. Vol. 69, No. 11: New Bands of the Ionized Nitrogen Molecule. By F. H. Crawford and P. M. Tsai. Pp. 407–437. 60 cents. Vol. 69, No. 12: The Relation of the Eyes to Chromatophoral Activities. By G. H. Parker, F. A. Brown, Jr., and J. M. Odlorne. Pp. 439–462+1 plate. 60 cents. (Boston, Mass.)

U.S. Department of the Interior: Office of Education. Pamphlet No. 57: Aids in Book Selection for Secondary School Libraries. By Edith A. Lathrop. Pp. iii+28. 5 cents. Pamphlet No. 58: The Economic Outlook in Higher Education for 1934–35. By Henry G. Badger. Pp. 49. 5 cents. Bulletin, 1934, No. 3: Economics through the Elimination of Very Small Schools. By W. H. Gaumnitz. Pp. v+54. 10 cents. (Washington, D.C.: Government Printing Office.)

U.S. Department of the Interior: Geological Survey. Bulletin 857–E: Core Drilling for Coal in the Moose Creek Area, Alaska. By Gerald A. Waring. (Mineral Resources of Alaska, 1932.) Pp. ii+155–173+plates 6–9. 10 cents. Bulletin 864–A: Mineral Industry of Alaska in 1933. By Philip S. Smith. (Mineral Resources of Alaska, 1933.) Pp. ii+94. 10 cents. Professional Paper 185–A: Studies on the Alkalinity of some Silicate Minerals. By R. E. Stevens. (Shorter Contributions to General Geology, 1934–35.) Pp. ii+13. 5 cents. Professional Paper 185–F: A Lower Lance Florule from Harding County, South Dakota. By Edward Wilber Berry. (Shorter Contributions to General Geology, 1934–35.) Pp. ii+127–133+plates 25–27. 5 cents. Professional Paper 185–G: Halloysite and Allophane. By Clarence S. Ross and Paul F. Kerr. (Shorter Contributions to General Geology, 1934–35.) Pp. ii+135–148+plates 28–29. 5 cents. (Washington, D.C.: Government Printing Office.)

University of California Publications in Anatomy. Vol. 1, No. 7: On the Cutaneous Nerve Areas of the Forearm and Hand; their Sizes, Variations and Correlations studied in a Small Sample of Young Adult Males. By I. Maclaren Thompson, Verne T. Inman and Bernard Brownfield. Pp. iii+195–236. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.) 50 cents.

Proceedings of the United States National Museum. Vol. 83, No. 2975: Some Fossil Corals from the West Indies. By John W. Wells. Pp. 71–110+plates 2–5. (Washington, D.C.: Government Printing Office.)

CATALOGUES

Watson's Microscope Record. No. 34, January. Pp. 24. (London: W. Watson and Sons, Ltd.)

A Catalogue of Books and Periodicals on Botany, Agriculture, Forestry, Fruit-Culture, Gardens and Gardening, Herbals, Tobacco. (No. 499.) Pp. 94. (London: Bernard Quaritch, Ltd.)

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CONTENTS

	PAGE
History Based on Science	281
Mathematics before the Greeks. By T. L. H.	283
Animal Behaviour	285
Embryology and Genetics. By C. H. Waddington	285
Photo-electric Cells and their Applications	286
Short Notices	287
Radioactivity: Old and New. By the Right Hon. Lord Rutherford, O.M., F.R.S.	289
A New "Nomenclator Zoologicus"	292
Solid Carbon Dioxide	293
Obituary:	
Prof. Arthur Thomson	295
Prof. J. Macmillan Brown	296
Mr. Francis J. Blight. By J. S. H.	296
News and Views	297
Letters to the Editor:	
Deep Diathermic Effect and Localisation by Means of 'Auxiliary Dielectric Electrodes' in the Condenser Field.—Dr. Franz Nagelschmidt	303
Well Gauges as Seismographs.—Prof. Perry Byerly and Francis B. Blanchard	303
Sedimentation Equilibrium Measurements with Low Molecular Substances in the Ultra-Centrifuge.—Dr. Kai O. Pedersen	304
Use of the Centrifuge in Determining the Density of Small Crystals.—J. D. Bernal and D. Crowfoot	305
Mechanism of Respiration.—Prof. A. Szent-Györgyi	305
Cosmical Chemistry.—Prof. Henry E. Armstrong, F.R.S.	305
Wasting Disease of *Zostera marina*.—Clarence Cottam	306
Germination of Resting Spores of Onion Mildew (*Peronospora Schleideni*).—Robert McKay	306
Crystallisation of Human Serum Albumin.—Dr. Muriel E. Adair and G. L. Taylor	307
Stability of the Acetyl Radical.—M. Barak and Dr. D. W. G. Style	307
Diffusion of Gases through Metals.—Prof. Tito Franzini	308
Molecular Spectrum of Cadmium Vapour.—Prof. J. K. Robertson	308
Structure of $BrIII$.—K. R. Rao and S. G. Krishnamurty	309
Large Sunspot Group of February 1935.—C. P. Butler	309
Plasticity of Rock Salt Crystals.—Prof. E. N. da C. Andrade	310
Research Items	311
Effect of the Earth's Magnetic Field on Cosmic Rays in the Stratosphere. By Max Cosyns	313
National Water Policy in Great Britain. By Dr. Brysson Cunningham	314
The Process of Coagulation in Smoke	315
British Industries Fair, 1935	315
University and Educational Intelligence	316
Science News a Century Ago	317
Societies and Academies	318
Forthcoming Events	320
Official Publications Received	320
Recent Scientific and Technical Books	Supp. iii

History Based on Science

A POWERFUL, learned and convincing book which has just appeared will, it is to be hoped, turn the minds of many people, besides readers of NATURE, to the consideration of the subject raised in the title of this article. The book is the second volume of Prof. Preserved Smith's "History of Modern Culture",* of which the first volume was noticed in these columns on April 4, 1931 (127, 515). We shall have something further to say about it later on. The subject is the large one, still unrecognised by most thinkers in its true greatness, of the part which science has played, and is playing with increasing vigour as we write, in changing and building up the fabric of society.

It is, of course, a commonplace that the discoveries and applications of science are the leading feature of our own age. Some people deplore the effect of this development on ways of thought and life; others, like M. René Sand, more justly, point out the enormous advantages to health and happiness which have already accrued to mankind from this source, and the illimitable supply which is at our command for the future, if we have the wisdom to use it. No one disputes the fact. But the strange paradox faces us, that, though this is admitted with regard to the present, the historians, those whose business it is to show how the present has arisen from the past, scarcely pay any attention to science at all. Yet, surely, here again, we may start from two universally accepted truths; one, that the present is the child of the past and formed by it; two, that man is primarily the thinking animal, so that the history of his thought must be the most important part of his whole history. In spite of this, the vast bulk of the history still taught and written deals exclusively with politics and war. We are shown how men use and abuse their means of associating with one another. We are not shown the nature or the growth of the one thing in which their association is most perfect, and by means of which they have gained their power of controlling the external world.

Some people treat this as a purely academic question, to be settled by those who have the matter in hand. Authors, they say, must study and write about the things that interest them and their readers. If people want the interest of chemistry, they will get it, and, surely, there are plenty of histories of chemistry? One cannot,

* A History of Modern Culture. By Prof. Preserved Smith. Vol. 2: The Enlightenment, 1687–1776. Pp. vii+703. (London: George Routledge and Sons, Ltd., 1934.) 12s. 6d. net.

however, just leave the question unanswered, for there is a thing called 'history' quite apart from the special histories of chemistry, art, religion, etc., and it is this general thing, called commonly 'history', to which we are now referring. It is that which forms the staple of what is taught in schools as 'history', and of which people think, when asked, if they care about history or know much about it. This common or general thing is made up almost entirely of politics and war, and it is this which statesmen and reformers now have in mind when they set up committees "to examine the historical textbooks and eliminate obnoxious matter" (as now in London), or commission writers to produce new history books, inspired by a certain desired spirit (as now in Germany). Evidently, the men who take this executive action think that there is something to be gained by doing it, and, though they probably exaggerate the possible effects of their action, we must agree with them when they find something more in history than the mere gratification of a special interest and treat it as a matter of profound social and intellectual concern. Unfortunately, however, those thus criticising and prescribing history books only deal, as a rule, with the fringes or excrescences of the matter. They only notice the special points obnoxious to their own point of view, and the root of the whole mischief escapes them.

The best proof of the truth which we are trying to establish—and incidentally the best evidence of the mischief of missing it—is to be found in works where the authors are clearly free from such propagandist intent as we have just instanced, and seem obviously trying to present the facts as they were. It happens that a book of great learning and bulk has recently begun to appear in England and has been received with a chorus of approval by the Press. This is Prof. A. J. Toynbee's "Study of History", of which the first three volumes appeared in the autumn and several more are promised. It is in many points similar to the more famous work of Spengler, and in the matter now under discussion is open to the same criticism. The general thesis, enforced by a wealth of interesting detail, is that history should be regarded as the record of the birth, flowering and decay of a large number of independent civilisations which we may indeed group into more or less cognate families, but which have their hour and pass away like the individuals who compose them. Prof. Toynbee has in fact a special section in which he denounces the 'misconception' of the 'unity of civilisation', while Herr Spengler, as is well known, has discovered and explains the decay and disappearance of the Western civilisation around which this unity is commonly supposed to rest and to be growing.

It is, of course, largely a question of terminology whether we speak of many 'civilisations' which pass away, or of one human 'civilisation' which lasts and grows. But there is one supremely important point involved in the belief in a real unity of civilisation, whatever the temporary varieties under which civilisation may appear in China, Egypt, Mexico and the rest; and it is just this one supreme point which the authors mentioned, and many more, completely miss. The unity of civilisation does not mean the temporary unification of a large part of the earth's surface whether by an Alexander, a Roman Empire, a Genghis Khan, or the colonising armies of modern Europe. It means that the root of human civilisation is *one*, and is to be found in the development of the human mind, which is similar all over the world in its effective contacts with external Nature, and of which science—understood in the widest sense—is the most characteristic and most permanent fruit. It is because science in this sense is missed by these theorists, and the hosts of others less learned than they, that we have all this talk about passing away of civilisation, the decay of the West, the bankruptcy of man.

If we study carefully the various features of the 'civilisations', described by Prof. Toynbee and others as having 'passed away', we find that they consist mainly of forms of art, language and literature, which naturally do attain a perfection of form and then decay or are transformed into other shapes. Thus Latin literature reached perfection with Virgil and then decayed. The renascence with Dante took a new form, though even here it would be too much to say that Virgil was dead. But science differs in this respect profoundly. It is not an art-form like a Greek vase or an ode of Horace. The changes made in its expression—systems of numeration, use of cipher, indexes, equations and so forth—are not comparable to the temporary laws of metre or to styles in architecture. They are rather progressive attempts to simplify the apparatus of thought, to make the common human mind more competent in ordering its thoughts and dealing with phenomena. Greek geometry or the Hindu cypher is not a fashion. It is absorbed permanently by mankind, and, though it may be further simplified

or put into a still more general form, we all need to use it at some stage of our mental development.

This comparative illustration is surely an apt one, and may be extended with due qualifications to science as a whole, which is constantly approximating to the precision of mathematics. It is a common human possession, and a living and growing one, being in fact the best guarantee both of the unity of mankind and the future of civilisation. Clearly, therefore, on all grounds, it should take a foremost place in our apprehension of history and in our presentations of it to others. It is a difficult task, the most difficult perhaps in the whole of education; but it is scarcely too much to say that up to the present the attempts that have been made have either merely scratched the surface, or else burrowed so far below it that the work is not apparent to the mind of the average educated man. History remains for the mass that story of political and military events (largely the latter) to which we referred above. A book like that of Prof. Preserved Smith is, therefore, heartily to be welcomed, for he has the root of the matter in him. "Beginning," he tells us, "in the seventeenth century, men began to look forward and not back, to the future and not to the past, for the era of perfection. The reason for this is simply the triumph of science. By the end of the seventeenth century even the dullest could see that in knowledge of nature his contemporaries were superior to the most renowned of the ancient worthies."

Vol. 2 of Prof. Smith's work covers the years from 1687 to 1776, and is called 'The Enlightenment', implying that awakening of the European mind to its possibilities which followed the scientific revolution of the seventeenth century. True to his estimate of the relative value of the various factors in the intellectual evolution of the time, Prof. Preserved Smith devotes his first section to science, the next to philosophy, the next to history, and so on. It is a fairly complete and well-documented account of the intellectual output of nearly a hundred years preceding the French Revolution. The author's reading is enormous, his style is clear and often pointed, and his quotations always apt and often amusing. But, praise and enjoy it as we may, one cannot feel that we yet have the comprehensive and well-knit survey of history, inspired by science, which is the great desideratum. This book is rather an interesting encyclopædia of a definite and important part of modern thought, full of profound reflections connecting one section of the picture with another, but not a forward-moving account of the whole as an expression of the growth of the human soul in that period, which the ideal requires. There are so many trees in the forest, and we are so much interested in studying and comparing their shapes, that we tend to forget where it lies on the earth's surface and where it leads us. The work of clear but sound synthesis in history still remains very largely to be done, especially in England, which is in practical ways the most historical of countries.

In theoretical work of this kind we are now, as often before, outdistanced by others and perhaps most of all by the French. This synthesis, the most needed for moral and international reasons, must be based on the subordination of other aspects of history to that of the growth of thought, and it will trace this growth from the humblest beginnings with the first ape-man to the conquering intellect which now embraces the universe.

Reviews

Mathematics before the Greeks

Vorlesungen über Geschichte der antiken mathematischen Wissenschaften. Von O. Neugebauer. Band 1: *Vorgreichische Mathematik.* (Die Grundlehren der mathematischen Wissenschaften in Einzeldarstellungen, herausgegeben von R. Courant, Band 43.) Pp. xii+212. (Berlin: Julius Springer, 1934.) 19.60 gold marks.

MUCH work has been done during recent years in the decipherment and elucidation of ancient Babylonian mathematical texts, and most of all by Dr. Neugebauer, the editor of this volume. It is not too much to say that no such treasure trove has come into the possession of historians of mathematics since the year 1906, when Heiberg discovered in a palimpsest at Constantinople the tract by Archimedes called by him the "Method", which was supposed to have been lost.

Since the publication of that work, other things have indeed come to light. One is the solution by Archimedes of the problem of inscribing a regular heptagon in a circle; another is the Moscow papyrus acquired by the Museum of Fine Arts at Moscow in 1912 and at length published by W. W. Struve in 1930. But these things have added much less to our knowledge of ancient mathematics than the series of cuneiform texts the content of which is set out in the volume before us. Dealing with Egyptian as well as Babylonian mathematics, Dr. Neugebauer justly claims that his is the first

attempt to give a comprehensive view of the history of pre-Greek mathematics, and we cannot be too grateful to him for his admirable exposition. It is intended to be followed in due time by two more volumes; vol. 2 will deal with Greek mathematics, while vol. 3 will treat of exact astronomy and particularly the classical work of Ptolemy on one hand, and, on the other, Babylonian astronomy of a relatively late date, the facts about which are much less accessible and more difficult to appraise.

The present volume is divided into five chapters. The first is on the technique of Babylonian numerical calculation (36 pages); the second (41 pages) contains a general historical account of the language and writing of the cuneiform texts, the Babylonian mathematical terminology, and finally the Egyptian hieroglyphic and hieratic scripts. Chap. iii (30 pages) describes the Babylonian and Egyptian numeral systems, the notation for whole numbers and fractions, and lastly the sexagesimal system of arithmetical notation and its development as a 'position-value' system of the most thoroughgoing kind. Chap. iv (56 pages) gives a general and complete account of Egyptian mathematics, the geometry of areas and volumes, arithmetic including fractions and their manipulation, and problems equivalent to elementary algebraical equations. Chap. v (42 pages) describes at length the whole content of Babylonian mathematics as it now appears in the light of all the texts so far investigated. The headings include geometry, arithmetic and algebra. Algebra includes linear equations with a number of unknowns, quadratics with one or two unknowns, and some cubic equations; there are also some problems in simple and compound interest.

Babylonian geometry is mostly the mensuration of areas and volumes (π is taken as 3, not such a good value as the Egyptian approximation); but calculations of the 'sagitta' of a chord of a circle by means of the lengths of the diameter and the chord, and the converse, involve the use of the Pythagorean theorem of the square of the hypotenuse. The Babylonian arithmetic and algebra are far more remarkable, for the dates (about 2000 B.C.) to which the texts belong. In arithmetic the sexagesimal scale is consistently used instead of the decimal; each number (up to 59) corresponding to our 'digit' means some power of 60; numbers are expressed as the sum of descending powers of sixty followed by units and then by successive sexagesimal fractions; 'position-value' is fully secured by the existence of a sign, corresponding to our 0, to indicate the absence of a particular denomination. The Babylonians did not even trouble to specify any denominations; they left them to be inferred from the context; thus 30 may anywhere mean $\frac{1}{2}$ as easily as 30 units, and so on. To divide one number a by another number b, they took the reciprocal of b ($1/b$), expressed it as a sum of successive sexagesimal fractions, and multiplied a by $1/b$. For this purpose they had tables of reciprocals, just as they had multiplication tables; the reciprocal of 1 21 (81 in our notation) is given as 44 26 40, which means in this case 0 44 26 40 (there being no units in the expression but only sexagesimal fractions); the product of 1 21 and 0 44 26 40 will be found to be 1.

The Babylonians solved quadratics without stating any general formula; but they calculated the root in concrete figures precisely in accordance with the formula as given in our textbooks; the unknown quantities are not called x, y, z (or by any equivalent symbol), but they are the 'length', 'breadth', 'depth', etc., respectively in some geometrical figure. Problems leading to some cubic equations constitute somewhat of a puzzle. Some produce an equation of the form $x^3 + x^2 = a$; and the key to the solution in this case was discovered by Neugebauer in certain tables of numbers of the form $n^3 + n^2$. Other cases are not yet explained, and it may be that the root was known beforehand and the problem framed accordingly. There are some approximations to the square roots of non-square numbers; one uses the approximation $a + (b/2a)$ for $\sqrt{(a^2 + b)}$, which is common in Greek mathematics. In view of the Babylonians' proficiency in algebra about 2000–1800 B.C., it is extraordinary that no *arithmetical* solutions of quadratic equations (as distinct from geometrical solutions) are found in Greek writers before Heron and Diophantus.

In the account of Egyptian mathematics (chap. iv), there is not much that is new in substance, but the exposition is succinct and comprehensive, and new points of view frequently emerge, especially with regard to the dexterous way in which the Egyptians manipulated their fractions, which (except for $\frac{2}{3}$ and occasionally $\frac{3}{4}$) were confined to submultiples and sums of such. There is a useful discussion of problems 14 and 10 of the Moscow Papyrus, the first of which uses the correct formula for the volume of a frustum of a pyramid with square base, while the second purports to give the superficial area of a certain curved surface. It is interesting to note that Dr. Neugebauer inclines to Peet's interpretation of the language of the latter problem, which makes the surface measured to be a half-cylinder and not a hemisphere as supposed by Struve.

As a matter of printing, the volume is beautifully produced; altogether, it is a fine piece of work, and cannot be too strongly commended.

T. L. H.

Animal Behaviour

The Behaviour of Animals: an Introduction to its Study. By Dr. E. S. Russell. Pp. viii+184+6 plates. (London: Edward Arnold and Co., 1934.) 10*s.* 6*d.* net.

THIS small book is a model of its kind, providing, as it does, an excellent summary of the existing knowledge of animal behaviour, and being full of suggestions with regard to further profitable experimentation. But it is more than a pleasantly written résumé, compiled by a man who obviously knows his subject and is intrigued by the many problems in this field which seem to defy human understanding. It is a challenge to zoologists.

With very few exceptions, animal behaviour is a study sadly neglected by professional zoologists in Great Britain; so neglected that its territory has been claimed by the physiologist and psychologist. In this fact danger lurks, for, as Dr. Russell argues, quite commonly the proper place for the study of animal behaviour is not the laboratory, and since the physiologist and psychologist are not necessarily naturalists, as the zoologist must needs be, the manner in which an animal lives and maintains itself in Nature has been almost completely disregarded.

Dr. Russell is perfectly justified in his view that shepherds, fishermen, fanciers and sportsmen have much of importance to tell the biologist, for those of us who know these men and have captured their interest are greatly indebted to them. They have vast stores of accurate information which, properly examined, and freed from anecdote and conjecture, can be made to reveal matters of profound scientific value. It is true that their interpretations may not, and usually do not, coincide with our own, but the extent of their knowledge of the habits of the commoner beasts and birds is astonishing. They may know nothing of mechanisms, but they do know a great deal of the animal as a whole. Thus it is that Dr. Russell finds himself happy in their company, for he strenuously revolts against the purely mechanistic view and pleads for a return to the Aristotelian approach, according to which life and mind are regarded as continuous one with the other, the basis of the zoological system being the form and the behaviour of the animal as a single entity.

The author strongly emphasises the value to science of recording as fully as possible the normal everyday activities of animals, especially in the wild; of describing the objective facts in the simplest and most comprehensive way, disregarding all speculation about the animal's inner life, and studying only the overt and visible actions. Dr. Russell teaches that behaviour is always directed toward some definite end, and is largely determined by its result, the action continuing until the goal is reached; that behaviour is often active or spontaneous in the sense that it is not a reaction to external stimuli, and that animals perceive an external world of their own. Thus, in studying animal behaviour, the first question to be asked is: What is the animal trying to do? The second: To what exactly does it respond, that is to say, what does it perceive? The third: How does its behaviour develop through maturation and through experience? Finally: Is the animal's behaviour modifiable or adaptable?

The book considers these matters in some detail and illustrates the methods of simple, direct observation without theory and without analysis. It leaves all questions on mind and matter to the philosophers. It is addressed to students of biology and to the general public, and to these it can be strongly recommended. Reading this book, one is driven to the conclusion that no zoological curriculum can be regarded as being complete unless it includes a course of animal behaviour given by someone with Dr. Russell's knowledge and devotion to his subject.

Embryology and Genetics

Embryology and Genetics. By Prof. T. H. Morgan. Pp. viii+258. (New York: Columbia University Press; London: Oxford University Press, 1934.) 15*s.* net.

ONE of the most serious gaps in the whole structure of theoretical biology is the lack of connexion between the concepts of genetics and of embryology. Both sciences have a peculiar importance for biology because they both deal with their subject matter in a particularly objective way. The organism is not analysed along any of the lines worked out by the older physical sciences, but the path of analysis grows directly out of the reactions which are observed. In this respect, genetics has been conspicuously successful, so that we can now, theoretically at least, represent an organism symbolically as a set of genes. In practice, we cannot give a completely sufficient representation of an organism in this way, but we can often state precisely the way in which it differs from its fairly near relatives. It is as though we knew the active groups of a complex organic molecule, but not the molecular nucleus.

In genetics, one gene stands symbolically for a whole series of developmental stages, so that it may be said to determine a red eye at one stage, for example, and a black eye at another, like some of the genes discovered by Huxley and Ford in

Gammarus. It should be the province of embryology to lay bare the basis of such series and to find how genes interact to produce their final effects. This involves an analysis of the whole process by which a complicated adult organism is developed out of an apparently simple egg-cell, and has been found to be an extremely difficult task. As yet, experimental embryology has been chiefly concerned with the blocking in of the main features of the future organism, and has found itself dealing with characters which are not much affected by the genes described by geneticists, characters in fact which, to pursue the analogy mentioned above, seem to depend on the molecular nucleus in the formula for the organism.

There could be no one more fitted to explain the importance of these matters than Prof. Morgan, who is at once a well-known experimental embryologist and the foremost geneticist of his time. His book should appeal to a wide public, since although not entirely popular, it is written in a way which makes it comprehensible to scientific workers who have not previously taken particular interest in the questions under discussion. A general reader will find here one of the most lucid summaries of experimental embryological research into such questions as the development of isolated blastomeres or egg fragments, or the artificial production of twins. The results of these inquiries cannot easily be summarised, and an account of them therefore occupies more space than need be devoted to the clear-cut results of genetical experiments, which have led to a very few generally applicable hypotheses.

The confused mass of data obtained by the older experimental embryology is at last beginning to be put in order under the influence of the recent work of Spemann, who registered the first success in the attack on the fundamental problem of embryology. This problem is, I take it, the question of why a given part of the embryo develops into a given part of the adult, and Spemann's answer, that it does so because it is stimulated to do so by an organiser, is only the first crude beginning of the analysis, comparable to saying that a muscle contracts because it is stimulated to do so by a nerve. But crude though it may be, it is the best we can do as yet. The importance of having any answer at all, even if we have some doubts as to how widely it can be applied, is so great that it is primarily in connexion with these theories that we shall have to examine the relevance of the ideas of genetics.

Prof. Morgan, by a self-denying ordinance, rigidly denies himself all speculation on this subject, but indications are not lacking that it will soon be possible to attack the problem. Already there is the significant fact that when an organiser induces an organ, the reacting tissue develops its own peculiar specific characters. Seidel's demonstration that the activity of the *Bildungszentrum* in the insect egg depends on the interaction of the nuclei and the cytoplasm is another hint. We already know something about the action of genes which affect some of the better understood biochemical systems, such as the system which leads to the formation of pigment in some animals. It is probably not too much to hope that our knowledge of the chemistry of organiser action will soon develop to a similar level. But as yet we have no idea how to explain the action of genes which determine pattern. Some aspects of this, the most difficult problem of morphology, are considered fairly fully by Morgan, who gives us two chapters on the production of two embryos from one egg, or one embryo from two eggs. These two chapters, like the rest of the book, raise in a most fascinating way a series of important problems, at the answers to which Prof. Morgan is too cautious to guess in our present state of ignorance.

C. H. WADDINGTON.

Photo-electric Cells and their Applications

Photoelectric Cells: their Properties, Use and Applications. By Norman Robert Campbell and Dorothy Ritchie. Third edition. Pp. vii+223. (London: Sir Isaac Pitman and Sons, Ltd., 1934.) 12*s*. 6*d*. net.

THE third edition of this book is, as its authors point out, practically a new book altogether, though certain portions of the previous editions are retained without much alteration. The differences arise not so much from the new material which has become available since the last edition was issued—though this is considerable—as from a change in the balance of the treatment, and in the class of reader for which the book is intended. It is now less of a handbook for those who actually want to use photo-cells, or a textbook on the theory of the photo-electric effect, than a book for those who might want to use them, and do not object to a somewhat abstract method of treatment.

This edition is divided into three sections, dealing respectively with the properties, methods of use, and some of the applications, of photo-cells. The first section is that which differs most from the last edition. It starts with a moderately full, though not mathematical, account of the theory of the internal and external photo-electric effects and of rectification at thin films, based on the idea of stationary states for the 'free' electrons in metals and semi-conductors. This is followed by full and clear accounts of the properties of vacuum

and gas-filled emission cells, of rectifier and of conductivity cells. These are accompanied by a large amount of illustrative data given in the form of diagrams.

The next section deals in a moderately detailed way with the manner of using photo-cells. It starts with an abstract account of the principles of measuring instruments with special reference to photo-cells. This is followed by two chapters on the measurement of the small currents which arise when the photo-cells are used with light of low intensity, and with valve amplification of the output from a photo-cell. The modern four-electrode electrometer valve has replaced the valve bridges previously described, and mention is made of the use of the galvanometer in ballistic fashion. The final chapter deals mainly with 'ticker' methods of measuring the current.

The final section is called "Some Applications of Photoelectric Cells", and is the least satisfactory part of the book in that it gives the impression of being merely the summary of a much more extensive treatment of the various branches of photometry by means of photo-cells. (May we hope for such a treatment as a separate book in the near future?) It gives, however, a useful comparison of many ways of using these cells for the measurement of light intensities.

The book is not quite free from misprints and slips of the pen, but these are few. The printing and paper are an improvement on those of the last edition.

Short Notices

Die Dreielektrodenröhre und ihre Anwendung: Übungen an der Dreielektrodenröhre mit den zugehörigen theoretischen Erläuterungen. Von Dr. Friedrich Moeller. (Abhandlungen zur Didaktik und Philosophie der Naturwissenschaft, Heft 15.) Pp. vii+155. (Berlin: Julius Springer, 1934.) 9.60 gold marks.

DR. MOELLER'S book is designed for students, and it is a recommendation that it deals with the subject from both the theoretical and practical points of view. The object of the author is set out in his foreword: ". . . the theoretical portion of the book can be looked upon as a text-book of the electron-valve, which attempts to explain the simpler problems of valve-theory without the necessity for special prior knowledge of A.C. technique".

The subject matter is divided into five main parts, and these are subdivided into 'Theory' and 'Practical'. The parts deal with (1) the valve itself, and its properties, giving the definitions of 'slope', *Durchgriff*, etc.; (2) triodes with resistance anode loads—amplification and power output; (3) triodes with tuned circuits, including H.F. amplification and self-oscillation; (4) modulation; and (5) demodulation.

It is felt that the author has undertaken a very difficult task in attempting to cover satisfactorily the theory of all this ground even to the extent required for a textbook of the triode for students, in a book of 150 pages; and when, in addition, space is allotted to practical experiments, some omissions are inevitable. Thus, although the book does cover a large part of the ground in a very thorough way (often, we feel, too thoroughly), a number of important problems are omitted or dealt with very briefly, and one is often left with a feeling of incompleteness. The practical considerations are not always dealt with in the best way, and often digress into further theory.

Nevertheless, judged by the amount of information that has been included, the omission of advanced mathematics, and the suggestions for practical confirmation of results, the book should form a very useful addition to the series of scientific textbooks of which it forms the fifteenth volume, and should provide a good starting point for a radio student.

The phraseology of the book is moderately straightforward, and anyone with a fair knowledge of the German language should have little difficulty in reading it, though the reasoning often seems unnecessarily involved, and the methods rather cumbersome. Its value as a textbook and more so as a reference book would be improved by the addition of bibliographical references, there being at present only some half-dozen, and these to other volumes of the same series.

Handbuch der Biochemie des Menschen und der Tiere. Herausgegeben von Prof. Dr. Carl Oppenheimer. Zweite Auflage. Ergänzungswerk, Band 2. Pp. xix+961. (Jena: Gustav Fischer, 1934.) 71 gold marks.

IN a review of the last published supplementary volume to this work—1154 pages, in two half volumes, bringing vols. 1, 2 and 3 of the second edition of the "Handbuch" up to the end of 1932—it was stated (NATURE, 133, 595; 1934) that the volumes were of the type that filled "the user with awe-inspired gratitude and the reviewer with awe-inspired terror". A similar effect is produced by the second supplementary volume; it brings the main vols. 4, 5 and 6 up to, presumably, the same date; it occupies, with its index, nearly 1000 pages; and it is apparently just within the 'single volume' limit.

This makes it somewhat unwieldy, as well as somewhat unviable in the unbound form. Still, the names of some of the contributors, Profs. L. Pincussen, J. Wohlgemuth, W. Grimmer, A. Scheunert, E. Grafe—to select at random a few, none of whom contributed to the first supplementary volume—will almost certainly secure that the possessors of paper-bound copies hasten to get a volume of such obvious value put into boards as quickly as possible.

The contents of this supplementary volume are divided in the following manner. The supplement to vol. 4 is concerned with the chemistry of tissues and organs, including blood and lymph, skeletal and epidermal structures, muscle, the apparatus of circulation and respiration, the nerves and sense organs, and the chemistry of tumours. The supplement to vol. 5 deals with the glands and secretory organs, which are classified into those involved in digestion and those involved in reproduction. The supplement to vol. 6 covers the general field of nutritional processes, including digestion, absorption and excretion. Finally, vol. 7 is brought up to date under the subheadings of nutrition, gas exchange and general metabolism.

It is clearly impossible to do more than indicate here in a quite general way the field surveyed in this book; the largeness of the field is in itself a measure of the vastness of territory mapped in the original work to which this is the second supplementary volume.

A. L. B.

Radio round the World. By A. W. Haslett. Pp. vii+196+7 plates. (Cambridge: At the University Press, 1934.) 5*s.* net.

THIS volume presents an interesting account, in a form suitable for the layman, of the main facts accompanying the application of electric waves to radio communication. A brief, historical account of the earliest discoveries of these waves includes a reference to the doubts and difficulties which accompanied the pioneer workers of some thirty years ago. The story of the propagation of electric waves of all lengths round the world, by the aid of the ionised layers in the earth's atmosphere, is then developed in a straightforward and skilful manner. A chapter entitled "The Sun calls the Tune" is noteworthy in this portion of the book, and directs attention to the various ways in which the possibilities of long-distance radio communication are controlled or limited by solar influence.

Later chapters utilise an account of the trend of modern developments to indicate the future possibilities of radio technique, particularly in the application of ultra-short waves to secret communication for war purposes, to television, and, by no means least important, to the introduction of a new phase of curative medicine.

On the whole, the author has obviously taken a good deal of trouble to get his facts correctly stated, although p. 160 contains, in a loosely worded sentence, a bad misrepresentation of the possibilities of radio direction finding. A reviewer in another country might complain that in certain portions of the book undue stress is placed upon recent British work in radio research; while in other places, the author has omitted to mention the Radio Research Board, from the publications of which so much of the material has obviously been derived. These are, however, minor blemishes in an otherwise successful effort to show the general reader how very much more there is in the science and practice of radio communication than the mere dissemination of broadcast programmes.

Annales Bryologici: a Year-Book devoted to the Study of Mosses and Hepatics. Edited by Fr. Verdoorn. Supplementary Vol. 4: *Studien über Asiatische Jubuleae (de Frullaniaceis 15–17) mit einer Einleitung: Bryologie und Hepaticologie, ihre Methodik und Zukunft.* Von Fr. Verdoorn. Pp. viii+231. (The Hague: Martinus Nijhoff, 1934.) 6 guilders.

A SKETCH of the progress of hepaticology occupies the first thirty-six pages; a knowledge of early authors is considered essential in questions of nomenclature and in dealing with types of genera; Evans, Howe, Lindberg, Schiffner and Spruce are authors favourably mentioned, but Stephani's "Species Hepaticarum" is very frankly criticised; its errors and other faults are considered to be so grave, that setting it aside as "opus excludendum" is discussed; in view however of its wide acceptance, that course is inexpedient and revision is recommended. Improved methods, geographical, cytological, genetical, experimental morphological, etc., are urged in the study of liverworts; the weakness of much recent bryological literature is referred to. Revision is the most urgent need of to-day; progress will largely depend on the study of the smaller groups, which are insufficiently understood.

De Frullaniaceis xv–xvii (pp. 40–224) carries on work published in earlier supplements. Dealing with the Lejeuneaceae, original diagnoses are reproduced as being often inaccessible to workers in Asia; there is a clavis to the fourteen genera, with notes on variability distinguishing characters, distribution and stations. Section xvi is a revision of the Asiatic Tamariscineae; a restricted but definite specific value is given to the Ocelli and a clavis to the six Asiatic species relies upon characters of the lobi, amphigastria and ocelli. Section xvii deals with some recent collections and the distribution of Indomalayan Frullaniaceae and Holostipae.

Strahlung und Lichterythem. Von K. W. Hausser und seinen Mitarbeiten. Herausgegeben von C. Ramsauer und R. Kollath. (Ostwald's Klassiker der exakten Wissenschaften, begründet von Wilhelm Ostwald, neu herausgegeben von Wolfgang Ostwald, Nr. 239.) Pp. iv+89. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1934.) 4 gold marks.

THOSE who knew the late Dr. Hausser will find much pleasure in the fact that the memory of this brilliant young physicist, who died in 1933 at forty-six years of age, is honoured by the publication of his original papers on the action of sunlight on the human skin as one of "Ostwald's Klassiker". Hausser was a pioneer in this branch of biophysics, for he was the first to realise the importance of using monochromatic light of measured intensity in the investigation of the causes of erythema and sunburn, by means of his large quartz prisms. He was responsible for the discovery of the fact that the human skin is particularly sensitive to two regions of the violet portion of the spectrum, one of which is normally absorbed by the atmosphere. All interested in biophysics would do well to possess this little book.

Radioactivity: Old and New*

By the RIGHT HON. LORD RUTHERFORD, O.M., F.R.S.

I WAS much honoured by the invitation to give the first course of the Joly Memorial Lectures. As is well known, Joly was for many years not only intensely interested in the problems of radioactivity, but also made numerous original and important contributions to our knowledge of this subject. When the large and continuous emission of heat from the radioactive bodies was made clear in 1903, Joly's alert and original mind was at once attracted to the problem of the effect of this steady generation of heat by the radioactive bodies present in the earth's crust on the geological history of our planet. To obtain reliable data, he devised simple but ingenious methods for measuring the amount of the primary radioactive bodies, uranium and thorium, in typical rocks constituting the earth's crust. He was the first to point out the far-reaching significance of this small but steady supply of heat on the internal temperature gradient of the earth, resulting in violent movements in the earth's crust. Indeed, he was of opinion that the rise and fall of continents and the elevation of mountain chains were intimately connected with the heating effect of radioactive bodies over long intervals of time. A fascinating account of these bold and original ideas has been given by Joly in his books and papers.

Of all the contributions made by Joly in the field of radioactivity, the discovery of the origin of the pleochroic haloes, observed in certain kinds of mica, has left the strongest impression on my mind. It required not only an acute and original mind but also a touch of real genius to connect these minute haloes, the origin of which had long been a mystery, with the effects of radioactive transformations. Joly, as the result of an intensive investigation, was able to prove that the darkening of the mica halo was due to the α-particles liberated over ages from a minute inclusion containing either uranium or thorium. In a well-developed halo, a series of rings was observed, each of which corresponded in radius to the range of one of the groups of α-particles liberated from the radioactive material. In this way, he was able to show that the processes of radioactive transformation were the same hundreds of millions of years ago as to-day. In some very old micas, Joly observed an inner ring corresponding to α-particles of much shorter range than any observed from the known radioactive bodies. To account for it he postulated the earlier existence of an unknown radioactive element which he provisionally named 'hibernium'. The researches of Hevesy in the last few years indicate that this ring is probably due to a known element, samarium, which has recently been found to be weakly radioactive. These haloes are produced by an exceedingly minute quantity of uranium or thorium as in inclusion in the mica. Probably the emission on an average of one α-particle every one hundred years continuing through geologic ages would give rise to a discernible halo.

I could give many more illustrations from other fields of inquiry which equally show that Joly possessed to a marked degree that rare quality of originality and vision characteristic of the greatest investigators of the past.

The property of spontaneous radioactivity is shown to the most marked extent by the heaviest elements, uranium and thorium, and the products which arise from their transformation. Only a few lighter elements show this property and those only to a feeble degree. We now know that the property of radioactivity is a sign of the instability of the atoms concerned. Take, for example, the best known radioactive element, radium. For some unknown reason, each second a minute fraction of the radium atom becomes unstable and breaks up with explosive violence, a fragment of the atom—an α-particle—being hurled out with high speed. As a consequence of these atomic transformations, a new type of atom is formed—the radium emanation—which in turn is unstable, breaking up rapidly with the liberation of an α-particle. The process of transformation once started proceeds through a number of successive stages, finally ending in the formation of a stable and non-radioactive isotope of lead. The successive transformations of uranium lead to the formation of twelve distinct types of radioactive element, and in all more than thirty of these radioactive elements are known. Each of these elements suffers transformation according to a definite law but at a different and characteristic rate. For example, radium is half transformed in 1600 years, the radium emanation in 3·82 days, and its succeeding product radium A in 3 minutes.

In most of the transformations, α-particles are alone expelled, but in a few cases the transformation is accompanied by the expulsion of β-rays, which are swift electrons. The mass of the atom is not sensibly changed by the expulsion of such a light particle, but the properties of the resulting atom are entirely changed. There is one important feature which distinguishes β-ray from α-ray transformations; all the α-particles escape with

* From the first Joly Memorial Lecture delivered at Trinity College, Dublin, on January 23, 1935.

identical speed and thus the transformation of each atom leads to the liberation of an equal quantity of energy. In the case of a β-ray transformation, one β-particle is expelled per atom, but the speed of the β-particle varies widely from atom to atom. If this be the case, one atom loses more energy than another, and we should consequently expect the energy content of the new atoms formed to differ. There is, however, no evidence that such differences of energy exist, and indeed when an α-ray body is formed by a β-ray transformation, the α-particles are again expelled with identical speeds. This difference between α- and β-transformations raises great difficulties and no satisfactory explanation is as yet forthcoming. It has been suggested either that the conservation of energy cannot be applied to such β-transformations, or that some of the energy from the atom is carried off in the form of an undetectable particle of very light mass called the 'neutrino'. We shall see that the same problem arises in the transformation of radioactive bodies which can be produced by artificial methods.

It is desirable at this stage to say a word about the nuclear structure of atoms. At the centre of each atom is a minute but massive nucleus which carries a resultant positive charge. This charge controls the number and arrangement of the electrons which surround the nucleus. The properties of an atom are thus defined by a whole number which represents the number of units of charge carried by the nucleus. This fixes the number and order of the elements, but we now know that there are many species of the same element, defined by its nuclear charge, which have different masses. The number of these isotopes of an element varies; some elements like aluminium are apparently simple, but others like tin have a dozen isotopes varying in mass over a wide range.

The appearance of radioactivity results from the spontaneous transformation of the minute nucleus of an atom. The expulsion of an α-particle carrying two positive charges lowers the charge on the nucleus of the residual atom by two units, while the expulsion of a β-particle raises it by one.

If we are to effect the transformation of an element, we must in some way alter its mass or its charge. This can be done by adding or subtracting a particle, whether charged or uncharged, from the nucleus. This is easy in imagination but difficult in practice. The most effective way so far found is the bombardment method, involving the entry of a foreign particle into the structure of the nucleus and in some cases leading to the loss of a charged particle from the nucleus. We shall illustrate these different types of transformation by considering a few of the simpler typical cases.

The first proof of the artificial transformation of an atom was given in 1919, when it was found that the bombardment of the gas nitrogen by fast α-particles gave rise to the liberation of a number of fast protons which could only come from a disintegration of the nitrogen nucleus. It is now clear that about one α-particle in 100,000 comes close enough to a nitrogen nucleus to enter its structure. The α-particle is captured and momentarily forms a new nucleus of charge 2 units higher and of mass 4 units greater. This newly formed nucleus is unstable and breaks up with explosive violence, expelling a proton in the process. The mechanism of the reaction is given below:

$$_7N^{14} + _2He^4 \longrightarrow _9F^{18} \longrightarrow _8O^{17} + _1H^1.$$

The resulting stable nucleus is an isotope of oxygen of mass 17, which we now know to exist in small quantity in ordinary oxygen. About twelve light elements can be disintegrated by α-particles, and in all cases protons of characteristic speeds are emitted; the general mechanism of the reaction is probably similar, leading in all cases to the emission of a proton and the formation of a new but stable nucleus of mass 3 units greater.

During the last few years, another important type of transformation has been brought to light in which a new and strange type of particle called the neutron is expelled. The neutron, as its name implies, carries no electric charge, but has a mass about equal to that of the proton. Since it has no charge, it does not ionise the gas in its path and consequently shows no track in an expansion chamber. At rare intervals in its passage through a gas, it hits the nucleus of an atom in its path and shoots it forward with high speed. This struck nucleus is charged and ionises the gas, so that its track through the gas is shown in a cloud chamber. While these 'knock-ons' are comparatively rare, they form a very convenient method of detecting the presence of the invisible neutron and forming an idea of its velocity. One of the best ways of producing a supply of neutrons is to bombard the element beryllium with fast α-particles. The α-particle is captured and the resulting nucleus of carbon 13 breaks up into a carbon nucleus of mass 12, while a fast neutron is expelled. The mode of the reaction is shown below:

$$_4Be^9 + _2He^4 \longrightarrow _6C^{13} \longrightarrow _6C^{12} + \text{neutron}^1.$$

We are now able to produce neutrons in a variety of ways, not only by the action of α-particles, but also by bombarding different elements by protons and deuterons.

Still another striking type of transformation can be produced by α-particles, resulting in the artificial production of new radioactive bodies. In the transformations previously considered, the

residual nucleus is a known type of stable nucleus, and is non-radioactive. A radioactive nucleus is an unstable type of nucleus which breaks up with the emission of fast particles, ultimately forming another stable nucleus. The production of an artificial radioactive body was first noted by M. and Mme. Curie-Joliot by bombarding boron with fast α-particles. After bombardment for a few minutes, the boron continued to show a marked activity for an hour or so after it was removed from the bombarding source. This activity decayed in exactly the same way and according to the same laws as the ordinary well-known radioactive bodies, but the type of particle emitted was quite different. Strange to say, it was found that high-speed positive electrons, or positrons, were emitted, and not α-particles or negative electrons such as appear in the spontaneous transformations of the radioactive bodies uranium and thorium. In order to account for the production of a radioactive element by bombarding boron with fast α-particles, it seems clear that the transformation occurs in two stages according to the scheme below:

$$_5B^{10} + {}_2He^4 \longrightarrow {}_7N^{13} + \text{neutron}^1$$
$$_7N^{13} \longrightarrow {}_6C^{13} + {}_1\text{positron}.$$

In the first stage, the α-particle is captured by the boron nucleus forming an unstable isotope of nitrogen, N^{13}, together with the liberation of a fast neutron. This isotope of nitrogen does not exist in Nature and is transformed slowly into the stable isotope of C^{13} by the expulsion of a positive electron. The activity of the radioactive body N^{13} decays to half value in about 14 minutes. By using the activity of this body as an indicator of its presence, it was shown by chemical methods that the radioactive body was an isotope of nitrogen. In a similar way, by bombarding other elements, radioactive isotopes of phosphorus and silicon could be formed, each with a characteristic period of decay.

This new discovery was rapidly followed up in a number of directions. Prof. E. Fermi and his collaborators in Rome found that a large number of these radioactive bodies could be formed when the elements were bombarded by neutrons derived from the action of α-rays on beryllium. On account of the absence of charge, the neutron is able to enter the structure of even a heavy element, where the α-particle on account of its charge is ineffective. Even the heaviest element, uranium, when bombarded by neutrons, gives rise to at least four new distinctive types of radioactive bodies, with half periods of 15 seconds, 40 seconds, 13 minutes and 100 minutes. The actual nature of the transformations involved has only been studied in a few cases. In all known cases, the neutron is captured; sometimes a heavy particle, an α-particle or proton, is emitted, but generally a higher isotope of the element is formed which may be unstable and emit negative electrons. It is worthy of note that all the radioactive bodies produced in this way break up with the liberation of fast negative electrons and not positive electrons, as in the original cases found by the Joliots. Cockcroft, Lawrence and others have found that bombardment of certain elements by fast hydrogen ions also gives rise in some cases to the production of new radioactive bodies.

It seems clear from these results that we are able greatly to increase our knowledge of the isotopes of the elements. None of these radioactive bodies are found in Nature, but represent unstable types of isotopes with a very limited life. During the last few months, it has been found that the efficiency of the process can be increased in some cases about a hundred times or more by slowing down the neutrons. This can be done by passing them through hydrogen or a solid material like water or paraffin which contains hydrogen.

We have so far spoken of the transformations brought about by the swift α-particles spontaneously expelled from radioactive substances, and the neutrons which arise from the bombardment of certain elements by α-particles. Another notable advance has been made by the use of bombarding particles produced artificially in the electric discharge and speeded up by appropriate methods. This involves complicated apparatus and in general the use of high potentials of the order of one million volts. In this way, copious streams of fast particles can readily be produced, corresponding in number to the α-particles expelled from thousands of grams of radium. Cockcroft and Walton were the first to show that transformation effects on a comparatively large scale could be produced by bombarding light elements like lithium and boron by fast protons. Time does not allow me to consider the mechanism of these transformations, which are different for each isotope of the same element. Transformation only appears to occur when the proton is captured by the nucleus, which then breaks up with explosive violence. Similar but different effects are observed when the ions of heavy hydrogen of mass 2 are used as bombarding particles. I would like, however, to refer to recent experiments in which it has been shown that artificial radioactive elements can also be produced by these new methods. Cockcroft and Walton and others have shown that ordinary carbon, whether bombarded by H^1 or H^2 particles, gives rise to the production of a new radioactive substance which decays to half value in about 11 minutes, emitting positive electrons in the process. It is believed that the

radioactive body formed in both cases is N^{13}, which is transformed into the isotope of carbon C^{13} by the emission of a positron. It is not yet settled whether this radio-nitrogen differs from that formed by α-rays, where the half period seems to be longer, namely, 14 minutes.

It seems likely that when very intense streams of still swifter particles are available, radioactive bodies of strong intensity may be produced by these artificial methods. It may be also that some of the bodies produced in these ways may give rise to a succession of changes such as is characteristic of the heavier elements uranium and thorium.

Sufficient, I think, has been said to illustrate the extraordinarily interesting results obtained in this fascinating field of inquiry. We can build heavier elements from lighter, and break up other atoms into fragments, and produce novel radioactive elements by the score. This new field of what may be called nuclear chemistry is opening up with great rapidity. Much work, often of a difficult technical character, will be required to prove the exact nature of any of the transformations which have been observed, but a very promising beginning has been made. Future work may disclose many surprises, for new and unsuspected particles may come to light. In any event, we are entering a no man's land with the ultimate hope of throwing light on the way atoms are built up from simpler particles.

A New "Nomenclator Zoologicus"

FROM the time that the tenth edition (1758) of the "Systema Naturæ" of Linnæus, which established the binomial system, was recognised as the basis of the nomenclature of animals, systematists have always had to face the difficulty of ascertaining what names have been used for genera. Since the same name cannot be validly used more than once in the whole of zoology, it is obvious that unless this information is reasonably accessible, many homonyms are inevitably created and themselves add to the confusion. Moreover, even when the existence of a name is known, it is often by no means an easy matter to find the original reference to it or to ascertain its position in the animal kingdom. Before describing the situation at the present day, it may be as well briefly to review the attempts that have been made to solve these problems.

The first Nomenclator to be published was that of Agassiz, which appeared between 1842 and 1846; it was followed by that of Marschall, which covered the period 1846–68 and was published in 1873. In 1864 there appeared the first volume of the "Zoological Record" which, however, in its earlier years, did not always include an annual list of new genera. The names in all these, with many others, were collected together by Scudder, who attempted a list of all published genera from Linnæus to 1879, and his work, which was published in 1882–84 as Bulletin No. 19 of the U.S. National Museum, is the only list of its kind that has yet been completed. It contains about 80,000 names. Supplements to Scudder's work are represented by the two volumes, edited by Waterhouse and published by the Zoological Society of London, of the new genera contained in the "Zoological Record" with some additions. These volumes together contain some 62,000 names, and cover the periods 1880–1900 and 1901–10 respectively. The new generic names in the "Zoological Record", which average about 2,000 per annum, have not been collected together since that date.

Sherborn's famous "Index Animalium", which was published between 1902 and 1933 and deals with both generic and specific names, though marvellously complete, only goes up to the year 1850. There also began to be published in 1926, under the auspices of the Prussian Academy of Science, an ambitious work entitled "Nomenclator animalium generum et subgenerum". If circumstances had permitted this to be carried through as originally planned, it would have been a very important contribution to the problem for the period that it dealt with. Though it appears to cover the ground with relatively few omissions up to about 1909 and it purports to include all names up to 1922, those dealing with the later years are taken almost entirely from the annual indexes to the "Zoological Record". The choice of the date 1922 was peculiarly unfortunate, because the "Zoological Record" was necessarily far from complete in the War years and those immediately following, with the result that it omits the very numerous names that were actually published during 1914–22 but were only found and recorded afterwards. Furthermore, only about three quarters of this German work have yet appeared, although it has been nine years in course of publication. Its use is therefore very limited, and it has the added disadvantage of being extremely expensive.

The present position is, therefore, that a systematist who wishes to erect a new generic name finds it almost impossible, even at the expense of much labour, to satisfy himself that any given one has not been used already. Not only are his sources of information very scattered and far from complete, but also many of them are rare and expensive.

The Council of the Zoological Society of London has therefore decided to make financial provision for a scheme to produce an entirely new "Nomenclator", in which an attempt will be made to include every generic name used in zoology from 1758 up to and including 1935. It is estimated that this will involve about 190,000 names, of which about 100,000 relate to insects. The names from 1758 to 1879 will be given their original references, these being taken, so far as those up to 1850 are concerned, from Sherborn. From 1880 onwards, the "Nomenclator" will take the form of an index to the "Zoological Record" itself. The class of animal concerned, or in the case of insects, the order, will also be given.

A very intensive search is being made of the literature to discover names that have been omitted from existing records, and this has already resulted in the discovery of some seven hundred in insects alone, chiefly among publications that appeared between 1900 and 1920. It is hoped also to enlist the aid of all systematic zoologists throughout the world in making the work as complete as possible, and a circular asking for their help is being sent out. In the course of this, they are asked to send details of any generic names, with their original references, to Dr. S. A. Neave, of the Imperial Institute of Entomology, 41 Queen's Gate, London, S.W.7, who is supervising the undertaking on behalf of the Zoological Society of London, and will also have the assistance, in particular groups, of experts at the British Museum (Natural History).

It is hoped that the work may be completed for publication about the end of 1937, and that it will be found possible to issue it at a moderate price.

Solid Carbon Dioxide

IT is just a hundred years ago since carbon dioxide was first solidified by Thilorier. Most chemists are familiar with carbon dioxide 'snow', which has long found use in the laboratory as a convenient means of producing temperatures down to about − 80° C. The comparatively small quantities required for such purposes were obtained by the simple but wasteful method of allowing liquid carbon dioxide from a cylinder to expand through a valve into a collecting bag; in these circumstances less than 30 per cent of the weight of the liquid used is obtained in the form of 'snow'.

Until about ten years ago, the solid was only used as a laboratory freezing agent, and also in small quantities medically as a cauterising agent. For the latter purpose the 'snow' was usually pressed into a solid pencil in a mould, making it more convenient to handle, and, owing to the reduced surface exposed, less rapid in evaporation.

The commercial development of the manufacture of solid carbon dioxide became a possibility only when refrigeration began to play a large part in the organisation of food supply. A great impetus was given by the rapid growth of the ice-cream industry in the United States, where the annual production (under the familiar name of 'dry ice') rose from a few tons in 1925 to approximately 27,000 tons in 1933. In Great Britain, production on a large scale commenced several years later, but it is estimated that the output in 1934 reached 10,000 tons, and demand for the product continues to expand.

In Great Britain, the gas for the production of solid carbon dioxide is chiefly derived as a by-product from industrial processes, such as the manufacture of synthetic ammonia, and in the production of alcohol. Purification in greater or less degree depending on the source of gas is required in all cases, including the removal of odoriferous compounds and of inert non-condensable gases which, under certain conditions, and if present in sufficient quantity, would render the liquefaction of the carbon dioxide difficult or even impossible. Following liquefaction of the gas, solidification may be brought about by various processes. These, while relatively simple, are very interesting from the physico-chemical point of view; and their development on the most economic lines has been the result of much research on the phase rule and thermodynamic aspect of the system. The process most commonly adopted is to allow the liquid to expand in suitable chambers with the formation of gas and 'snow', the latter being pressed into blocks of convenient size and shape, and the gas being returned for recompression. In another process, the liquid carbon dioxide is expanded in chambers at a pressure just below that corresponding to the triple point, and solid blocks are obtained without the use of a press, while according to a third process the liquid is frozen in moulds by the rapid evaporation of liquid ammonia. As might be expected, the several processes differ considerably in thermodynamic efficiency, although this is not reflected appreciably in the cost of production, power costs being only a small fraction of the whole.

Solid carbon dioxide in its commercial form is available in blocks of cylindrical or rectangular section, weighing approximately 25 lb. These blocks have the appearance of highly compressed snow and may be cut without difficulty by means

of an ordinary saw. The temperature of the solid under a pressure of one atmosphere of carbon dioxide is − 78·9° C., but when exposed to the atmosphere is somewhat lower owing to the reduction of partial pressure of carbon dioxide near the surface of the block. On account of the low temperature, gloves should always be worn when handling the solid. In a still atmosphere, a block of the solid evaporates more slowly than might be expected, mainly on account of the low conductivity of the enveloping film of gaseous carbon dioxide and of the high latent heat of sublimation of the solid (137 cal./gm. at − 78·9° C.). Thus a 25 lb. block requires about 24 hours to evaporate completely.

The most careful measures have to be taken to prevent needless waste by evaporation both in storage and transport, and to this end heavily insulated storage bins have been designed in which the evaporation loss has been reduced to 0·5 per cent a day, while the evaporation in large railway transport containers is of the order of only 2 per cent a day. Research into the most suitable types of container and insulating material has led to the development of a range of packages suitable for the transport of solid carbon dioxide, which enables this product to be sent from the producing centre to depots in all parts of the country, and thence to the user, with a very small total loss. Although the solid can be stored for very long periods without serious loss, it has been found that a limit is set by the slow growth of the crystals, which tends to produce disintegration.

As might be expected, the principal uses for solid carbon dioxide are in connexion with refrigeration. Its dryness, high latent heat and high density (1·4) render it attractive in many cases where the cost of removing heat units is not the only consideration. As already stated, the ice-cream industry was the first to adopt this refrigerant on a large scale in place of ice and salt mixtures, and the requirements of this industry continue to expand.

A considerable field exists for solid carbon dioxide in connexion with the transport of perishables, such as meat, fish, fruit and flowers, where controlled temperature conditions are required. As a result of the work which has recently been carried out under the auspices of the Department of Scientific and Industrial Research at Cambridge and at the Torry Research Station, and by other investigators, it is now known that carbon dioxide inhibits, in a marked degree, the growth of many of the bacteria and moulds which are largely responsible for the deterioration of meat and fish, so that the value of solid carbon dioxide as a refrigerant and preservative is further enhanced on this account. In preserving flowers, however, the effect is one of arrested metabolism due to the low temperature and the presence of carbon dioxide.

It may be remarked that, although the successful utilisation of solid carbon dioxide as a refrigerant presents no serious technical difficulties, care must be taken in the design of equipment such as ice-cream conservators, refrigerated transport containers and the like, if this refrigerant is to be used successfully and economically.

Except where the low temperature of solid carbon dioxide is specially required, means must be taken to reduce the heat flow to the refrigerant, and this can be done conveniently by interposing thermal insulation between the refrigerant and the cooled chamber. A number of other methods employing a secondary liquid are available.

Reference has already been made in NATURE (Oct. 6, 1934, p. 529) to the use of solid carbon dioxide in the assembly of machine components by means of shrink fits. The effect of the low temperature in contracting metal parts is best attained by immersing the parts in a suitable low freezing point liquid containing solid carbon dioxide. In this way rapid and uniform cooling results. The advantages of this method of shrink fitting are that it enables small components, such as cylinder liners, sleeves and valve seats to be readily inserted into housings without the use of a press, thereby obviating the possibility of distortion, and that the structure of heat-treated parts is not disturbed as might be the case with hot shrinking. Solid carbon dioxide is already being used in Great Britain in the production of automobile and aero engines, locomotives and machine tools, and this application is likely to expand considerably as it becomes more widely appreciated.

The use of solid carbon dioxide as a convenient means of obtaining a supply of the liquid or gas was first realised by Elworthy who, in a patent obtained in 1898, discussed the economic advantage to be gained from handling carbon dioxide in the solid form instead of as a liquid in heavy steel cylinders. It is only recently, however, that these advantages have been secured as a result of the development of solid carbon dioxide for refrigerating purposes, and the design of suitable containers and other apparatus. Pressure vessels ('liquefiers') are now available which enable the solid to be readily converted into liquid or gaseous form, and the use of solid carbon dioxide for purposes other than refrigeration is rapidly expanding. Foremost amongst these uses must be placed the carbonation and mechanical handling of beverages for which, it is needless to say, only solid carbon dioxide of the highest purity can be employed. For example, in 'Drikold',

manufactured by Imperial Chemical Industries, Ltd., organic esters and sulphur compounds are reduced to less than one part per million, and any oil which may be carried over from the compressors is carefully removed in order to obtain a sufficiently pure product. The solid is also finding increasing use as a source of carbon dioxide for the production of salicylic acid and other chemicals.

Passing reference only has been made to some of the principal uses of solid carbon dioxide. Certain other applications are still in the development stage, while others are constantly being discovered. The development of the industry has been very rapid and constitutes one of the most remarkable modern examples of the application of scientific methods to industrial requirements.

Obituary

Prof. Arthur Thomson

On his retirement in 1933, Prof. Arthur Thomson, whose death on February 7 will be widely regretted, had completed a somewhat unusual record of academic service. He was born on March 21, 1858, and for forty-eight years he represented human anatomy at the University of Oxford, first as University lecturer in human anatomy and afterwards as Dr. Lee's professor of anatomy. After serving an apprenticeship in the famous school of anatomy at Edinburgh under Sir William Turner, Thomson went to Oxford in 1885. Unlike many of his later contemporaries, he did not enjoy the advantage of stepping into a department already equipped for teaching and research. On the contrary, the task fell to him of building up a new department from its very foundations. It will readily be appreciated that Thomson's energies were fully employed for a number of years in developing the teaching side of his department to a level appropriate to the medical faculty of the University of Oxford, a task which was rendered very laborious at first by the criticism and opposition of some members of the University who were less ready to appreciate the importance of catering for an extensive and detailed medical curriculum.

Arthur Thomson's own contributions to scientific literature can be divided quite sharply into separate categories. Of these, his papers dealing with the racial variations of the skeleton are the most noteworthy. In this work he was clearly influenced by his late teacher, Sir William Turner, who had stimulated considerable interest in racial anatomy by his studies of the human skeleton in the *Challenger* Reports. Thomson's work on this subject was characterised by the fact that he constantly sought to explain by reference to habits of life and environmental influences the osteological variations which were being at that time recorded by anatomists. He was not content simply with measurements and with the construction of indices, and he was evidently reluctant to accept metrical variations of the skeleton as necessarily of real morphological significance in the assessment of racial affinities. In 1889 he showed the importance of considering posture as a factor in the determination of the proportions and contour of the lower limb skeleton and directed attention to the 'squatting facets' on the tibia and talus. In the same year he published an anthropometrical study of the Veddahs of Ceylon. His interest in craniology led him to investigate the significance of cranial indices which were then assuming such importance in the eyes of the anthropologist. By ingenious models he sought to show that the proportions of the calvarium must be directly influenced by brain volume and by the action of the temporal muscles. These observations were published in the *Journal of the Anthropological Institute* in 1903, and his conclusions, which were admittedly tentative, have in some part been substantiated by statistical study on a larger scale.

In 1913, Thomson made a valuable communication on the correlation of isotherms with variations in the nasal index. Ten years later, this observation was submitted to statistical analysis by him in collaboration with Dr. Buxton, with the noteworthy conclusion that a platyrrhine nasal index is associated with a hot moist climate and a leptorrhine index with a cold dry climate. Other studies by Thomson in this line include a comprehensive study with D. Randall-MacIver of Egyptian crania, published in 1905 by the Clarendon Press under the title of "The Ancient Races of the Thebaid", and a paper on the genial tubercles of the mandible in 1915. At Oxford, Thomson will be particularly remembered with gratitude for the part he played in instituting and organising the regular course of study for the University diploma in anthropology, a course which has met with increasing success since its initiation in 1907.

Thomson was a close personal friend of the late R. W. Doyne, who founded the Oxford Ophthalmological Congress, and undoubtedly it was this friendship which led him to make special studies of the anatomy of the eye. This resulted in the publication of two papers on the filtration angle of the eye in 1910 and 1911, and in a brochure on the anatomy of the human eye together with an atlas of stereoscopic photographs of dissections of the eye.

Thomson's last work was concerned with the microscopic structure of the human Graafian follicle and the maturation of the human ovum. These provided the subjects for two papers in the *Journal of Anatomy* in 1919.

Apart from his work at the University of Oxford, Thomson occupied the position of professor of anatomy at the Royal Academy, to which he was elected in 1900. In this sphere he was able to give full expression to his own artistic propensities, and he left an appropriate memorial of his contribution to art in his book "Anatomy for Art Students" which has passed through a number of editions.

PROF. J. MACMILLAN BROWN

WE regret to record the death of Prof. J. Macmillan Brown, chancellor of the University of New Zealand, and well known as an authority on the peoples of the Pacific, which took place at the age of eighty-nine years, at Wellington, N.Z., on January 18.

John Macmillan Brown was born at Irvine, Scotland, in 1846, the son of Mr. James Brown, shipmaster, and was educated at the Irvine Academy, the University of Glasgow, and Balliol College, Oxford, of which he was an exhibitioner. In 1874, on the establishment of Canterbury University College, he went to New Zealand to take up the appointment of professor of classics, and later became professor of English literature. In 1877 he became a member of the Senate of his University, and in 1923 was elected chancellor, an appointment which he held until his death.

Macmillan Brown was best known in England for his work on the problems of the Pacific, and more particularly for his somewhat speculative theories on the origin of the Polynesians and of the remarkable artistic products of Easter Island. His views were set forth in considerable detail and fully argued in his books "Maori and Polynesian", "The Riddle of the Pacific" (1924), and "Peoples and Problems of the Pacific" (1927). In the view put forward in the "Riddle of the Pacific" he argued that the famous statues of Easter Island are the product of workers on what was a mausoleum for a circle of islands, which have since disappeared owing to volcanic action. His theories of the peopling of the Pacific, which proved stimulating, if not entirely acceptable, brought the Polynesians as a Caucasic element from Asia, a primeval form of Indo-European. Whatever may be the ultimate verdict on his philological and ethnological theories, they undoubtedly had a stimulating effect in promoting the study of the peoples of the Pacific in New Zealand.

MR. FRANCIS J. BLIGHT

OLD scientific friends of Mr. Francis J. Blight will learn with much regret of his death at the age of seventy-seven years, on January 27 at his home at Mill Hill. Previously to 1927 he had been closely associated with Messrs. Charles Griffin and Co., Ltd., the well-known publishers of technical scientific books, and since 1899, when Miss E. E. Griffin died, he had been chairman and managing director of the firm, only retiring in 1927 in consequence of rearrangements following on the death of Miss Helen Griffin.

In early life, Blight, whose father and grandfather had been booksellers and stationers, had been for some years engaged in office work connected with iron and steel works, railway and other architecture, map-making, etc. He had thus become an expert draughtsman, with a wide knowledge of technical processes of many different kinds. In 1886 he became assistant manager to Messrs. J. and A. Churchill, the medical publishers, and in 1894 manager for Messrs. Griffin, then under the able chairmanship of Miss E. E. Griffin. Quickly realising the wide need for technical scientific books of all kinds, he developed this side of the firm's business with extraordinary energy and success, bringing out textbook after textbook which had large sales.

It was to a very great extent Blight's own personality that led to these books being written. He not only suggested them in many cases to men who, he saw, were likely to write them well, but also in their actual production was extremely helpful, particularly perhaps as regards the illustrations. It was an extraordinary stimulus and encouragement to meet him, as the writer of this short notice often did, in the well-known room at Exeter Street which was pervaded by his genial presence.

In 1920 a volume was published in celebration of the centenary of the Griffin firm, which had originated early last century at Glasgow. This volume contains sections dealing with the more recent publications of the firm in scientific technology, and written by Prof. Barnett, Sir T. Hudson Beare, Sir W. S. Abell, Prof. W. Gowland, Prof. Henry Louis, and other well-known authors. In a foreword to the volume, Lord Moulton stresses the national importance of technological publishing, and remarks that to Mr. Blight "the exceptional prosperity of the Firm, and its services to the country during the late war, must be primarily ascribed".

Only brief mention can be made here of another side of Blight's life. He was a keen supporter of the Baptist Church, and particularly of its charitable activities with respect to children and young persons. He also strongly supported all that has been done in this direction by State action and municipal activity. He was a man of simple character, in which love of his fellow-men was never overshadowed by either business or scientific interests. J. S. H.

MRS. JANE LONGSTAFF, who died on January 19, aged seventy-nine years, contributed important papers on Palæozoic gastropod shells to the *Quarterly Journal of the Geological Society*. She was the widow of Dr. G. B. Longstaff, a well-known entomologist, with whom she shared a wide interest in natural history. She was a fellow of the Linnean and Geological Societies, and was for some time a member of council of the Palæontographical Society. Her early writings were published under her maiden name of Jane Donald, and the value of her researches was acknowledged so long ago as 1898, when the Geological Society awarded her its Murchison Fund.

WE regret to announce the following deaths:

Mr. J. H. Benyon, Lord Lieutenant of Berkshire and chancellor of the University of Reading, a leading figure in agriculture and stock-breeding, on February 14, aged eighty-five years.

Prof. Bohuslav Brauner, lately professor of chemistry in the Charles' University, Prague, sometime Berkeley fellow of Owens College, Manchester, on February 15, aged eighty years.

News and Views

Robert Hooke's Diary

THE tercentenary of the birth of Robert Hooke, Gresham professor of astronomy, surveyor to the City of London and curator of experiments to the Royal Society, occurs on July 18 of this year. Hooke appears to have kept a continuous diary for the greater part of his life; and parts of his daily journal have been found in three different libraries. The importance of the first part was realised by Dr. Jean Pelseneer of Brussels, who directed the attention of the Royal Society to its existence in 1928; with the permission of the authorities of the Guildhall Library, Mr. H. W. Robinson made extracts, some of which were published by Dr. Pelseneer in *Isis* (February 1931). Afterwards, Mr. Robinson discovered another and later part of the diary in the British Museum, where for more than a hundred and sixty years it had been catalogued as the diary of James Petiver. The Guildhall portion of Hooke's diary is the most important, and is full of interest from all points of view. It records meetings of the Royal Society of which no minutes occur; elections of which there are no official records extant; details of his work as architect, surveyor and contractor; his daily visits to the coffee-houses and taverns, where he joined in the discourses and gossip of the city men; details of his private life, his income, his purchase of books and necessaries of life.

BY the courtesy of the Library Committee of the Guildhall, the part of Hooke's diary in the Guildhall Library can now be published. For many years Mr. H. W. Robinson and Mr. W. Adams have been carefully transcribing the diary, and it will be published, together with a short life of Hooke, by midsummer. The work of printing and publishing has been entrusted to Messrs. Taylor and Francis, who have undertaken to produce the book with the aid of a subsidy from the Royal Society. Of more than passing interest is the fact that the house occupied by Messrs. Taylor and Francis is supposed to have been built during the period of the diary, and most probably by Sir Christopher Wren and Robert Hooke. It may be remembered that Dr. R. T. Gunther has already published three volumes of Hooke's works in his series of books on "Early Science in Oxford".

Tribal Justice in Australia

A PERTINENT example of the practical bearing of the results of anthropological investigation is afforded by the defence set up in a trial for murder of two aborigines from Alice Springs, South Australia. The facts of the case are set out in a dispatch from the Adelaide correspondent of *The Times* in the issue of February 15. The defence rested on a plea of tribal justice. It has been put forward that the two accused were acting in accordance with custom and under the instructions of the elders of the tribe in putting to death a man who had revealed ceremonial secrets to a woman. Failure to comply, it was stated, would have entailed death. As might be expected, anthropologists have not failed in the endeavour to bring the aboriginal point of view before the court. Expert witnesses, however, were not heard; but their special knowledge was placed at the service of the defence. Ever since Spencer and Gillen first recorded, nearly forty years ago, the special reverence of the natives of Alice Springs for everything pertaining to tribal ceremonial, anthropologists would have been prepared to expect death as the logical consequence of so grave a threat to tribal safety as the breaking of taboo involved in the disclosure of ceremonial objects or procedure to a woman. It is, at the very least, the equivalent of a combination of high treason and sacrilege in a civilised community. As recent trials in Africa have shown, a court rooted in European law is not prepared to admit that in such cases tribal justice may demand and exact the supreme penalty, in the manner in which in a civilised society a traitor who discloses State secrets may be imprisoned for life or condemned to death. Those who carry out the sentence of the tribe must, in accordance with the laws of the country, be adjudged guilty of murder, even though the extreme penalty may not eventually be imposed.

Organisation of Agriculture in Australia

DIFFICULT circumstances in the agricultural industries of Australia are giving rise to much-needed co-operation between Commonwealth and States. In December last a conference of ministers at Canberra determined to establish an Australian Agricultural Council, to provide for continuous consultation among the Governments on economic aspects of agriculture, the members to be the Federal Minister for Commerce, the Minister-in-Charge of Development and Scientific Research and the State ministers concerned. This body will be supported by a permanent technical committee which is identical in personnel with the former Standing Committee on Agriculture of the Council for Scientific and Industrial Research, but which will now have greatly increased responsibilities. Its members are the six permanent heads of the State Departments of Agriculture, the three executive members of the Council for Scientific and Industrial Research, the Secretary of the Department of Commerce and the Director-General of Health. Besides its duties on the side of agricultural economics, this committee is charged with (i) securing co-operation and co-ordination in agricultural research throughout the Commonwealth; (ii) advising Commonwealth and State Governments, directly or through the new Council, on matters pertaining to the initiation and development of research on agricultural problems; and (iii) securing co-operation between Commonwealth and States, and between the States themselves in all quarantine measures relating to pests and diseases of plants and animals, and advising Governments thereon.

Training in Food Technology

THE Food Group of the Society of Chemical Industry met on February 13, at the London School of Hygiene and Tropical Medicine, to take part in a discussion on "The Training of the Food Technologist", opened by Dr. H. B. Cronshaw, editor of *Food Manufacture*, the *Industrial Chemist* and other publications. As Dr. Cronshaw's paper had been circulated before the meeting, he gave a brief summary of the more contentious parts and showed a number of slides illustrating numerous institutions, chiefly in North America, at which research and teaching in food technology are combined to various degrees. The main part of Dr. Cronshaw's paper, however, and that which gave rise to most discussion, contained a plea for the introduction in Great Britain of special post-graduate courses in food technology at suitable universities and colleges. Dr. Cronshaw's paper included a comprehensive and very useful survey of the kind of problems with which the food technologist is likely to be confronted, as well as some ingenious classifications of the type of product with which these technologists have to deal. For this reason alone its publication in full in *Food Manufacture* will be anticipated with much interest. His main plea, however, was subject to considerable criticism by various members of the Society, particularly on the grounds that it tended to over-emphasise the need of specialised technological knowledge in the young post-graduate entering industry, and so to run the risk of supplying him inadequately with the essential scientific outlook. Some of the discussion also directed attention to the importance of considering pre-graduate as well as post-graduate studies, and even of elementary and secondary education.

Museum of the History of Science at Oxford

ON February 12 Congregation at Oxford unanimously passed the statute which alters the name of the institution housing the Lewis Evans and other collections of scientific instruments to the "Museum of the History of Science, Old Ashmolean Building". The first step towards the full recognition of this institution—hitherto governed by decrees—has thus been taken. The museum is to be administered by the Vice-Chancellor, the Proctors and six others, three of whom will be appointed by the science boards. At the moment there will be no extension of the premises. A decree, however, was also passed assigning the main ground-floor room of the Old Ashmolean to the museum at a date not later than 1942. This room, where in the past the New Oxford Dictionary was compiled, and the present upper-floor room, where the collections now are, should be adequate for the museum for many years. It is a pity, however, that this increased accommodation, at the moment badly wanted, cannot be definitely secured earlier, and that the University cannot promise adequate financial support for the staff in charge. It is to be hoped that such help will soon be forthcoming, so that the museum may take a bigger part in the science teaching in Oxford—an opportunity for a generous donor. Congregation expressed themselves very appreciative of the work of Dr. R. T. Gunther, the curator, who not only created the museum single-handed more than ten years ago, but also has since given his services as administrator and teacher for a purely nominal salary.

Pollution at Sea by Discharge of Oil

IN July last, the British Government, stating that representations had been made to it that the pollution of the coasts of the British Isles by the discharge of oil and oily matter outside the territorial limits by ships was increasing, suggested that the matter be referred for preliminary examination to the Communications and Transit Organisation of the League of Nations, with the view of concluding if possible an international convention. At the last Assembly, this view was further explained by the British representative and it was decided that an initial inquiry should be undertaken. Experts from Denmark, France, Italy, Japan, the United States and Great Britain were invited to Geneva by the chairman of the Advisory and Technical Committee on Communications and Transit. These experts agreed that oil pollution caused the destruction of sea-birds, the wings of which become saturated with oil so that they cannot swim, fly or dive; of fish, particularly shellfish, and of the marine grasses which form the staple food of fish and sea-birds. The pollution of sea-beaches by oil results in harm to bathers and depreciation in value of seaside resorts, and constitutes a menace to public health; finally, the accumulation of oil drifting into harbours offers a serious risk of fire. These evils exist to a varying extent in many countries and the object in view is to provide, by international agreement, some means whereby oil-burning and oil-carrying ships may be prevented from polluting, through the discharge of oil and oily mixtures on the high seas, the coasts to which the matter is liable to drift. Some causes of pollution such as collision, or the pouring of oil on to the sea during storm to assist vessels in distress, cannot be prevented, but it is possible by co-operation to guard against voluntary discharge outside territorial limits, and the Committee of Experts recommend that an appropriate international convention should be concluded.

Security of Tenure and Intensive Farming

THE private bill promoted by the Metropolitan Water Board, which may involve the destruction of Holly Lodge Farm (see NATURE of February 2, p. 177), was read a second time in the House of Commons on February 18. Sir A. Boyd-Carpenter moved that an instruction be given to the committee which is to consider the bill to leave out works on this site, on account of the unique value of the farm as a research centre. After discussion, Sir Hilton Young, Minister of Health, pointed out that he had consulted the Minister of Agriculture on the matter and it was agreed that the appropriate means of dealing with the question was to refer it to a committee of the House. Sir A. Boyd-Carpenter's motion was then by leave withdrawn. In a letter in *The Times* of

February 15, Sir William Prescott, chairman of the Metropolitan Water Board, stated that the "site for the proposed reservoir at Walton has been selected after the most exhaustive examination of other available lands". It is not stated whether the expert opinion available to the Ministry of Agriculture or to the Geological Survey has been sought, but it is much to be hoped that such scientific advice may be consulted before the matter comes under discussion in committee of the House of Commons.

A New American Balloon Ascent into the Stratosphere

FOLLOWING on the American ascent into the stratosphere last year recorded in NATURE of July 28, p. 132 and November 3, p. 707, 1934, careful inquiry has now shown that the mishap was caused by internal adhesions of the lower part of the balloon fabric. Plans for a new ascent are well advanced. The personnel of the advisory committee has been chosen by the National Geographic Society working in co-operation with the United States Army Air Corps, and once again Capts. A. W. Stevens and O. A. Anderson will ascend. It is gathered from the announcement by the president of the Society in the *National Geographic Magazine* of February 1935 that the arrangements will differ but little from those of last year's flight. The balloon will have the same capacity and the ascent will be made from the same place. No details are as yet available of the instruments that will be carried, but as the lifting power will be about six tons and as "special emphasis is to be placed on data that can be obtained from manned balloons capable of lifting standard laboratory instruments", there is no doubt that every possible self-registering device that might supply information about the upper atmosphere and cosmic rays will be included. An advisory committee under the chairmanship of Dr. Lyman J. Briggs, director of the U.S. Bureau of Standards, is to be congratulated on the thoroughness of its investigations of the previous failure. The findings will be of greatest value to those who undertake future hazards.

A New Diphtheria Prophylactic

OWING to the prevalence of diphtheria during the last year, a considerable demand has followed for immunising agents for preventive inoculation, which is now extensively practised with good results. Various agents have been employed for this purpose, such as toxin-antitoxin mixtures and preparations of modified diphtheria toxin known as 'toxoid'. An alum-precipitated toxoid (A.P.T.) of high immunising efficiency is now available, and is issued by Messrs. Burroughs Wellcome and Co., in germ-proof containers of 1 c.c. and 5 c.c. This substance was first prepared in the Wellcome Physiological Research Laboratories in 1926. The results of animal tests showed that it possessed considerable immunising power against diphtheritic infection, and since that date its high immunising efficiency in human beings has been established. Caution has been exercised in applying the inoculation of A.P.T. in human beings on account of the production of a tissue response at the site of injection. This, though medically trivial, may disturb parents of inoculated children. The efficiency of A.P.T. probably depends upon the deposition of the relatively insoluble aluminium-toxoid compound at the site of injection, and from this the immunising toxoid is gradually liberated. The complex toxoid compound, however, excites a tissue response in the form of a small painless nodule, and this tissue response is probably an essential factor in the potent immunisation that ensues. Unpublished experiments made in the Wellcome Research Laboratories have shown that in animals two spaced injections of one tenth, or less, of the ordinary human dose results in a more rapid, or a higher, immunity than one single larger dose. It is possible that a similar method may prove useful in human immunisation, the chance of troublesome local reaction being lessened by this course.

Juan Fernandez and Easter Island

BY a recent decree of the Chilean Minister of Lands and Colonisation, it is reported by a correspondent of *The Times* in the issue of February 14, Juan Fernandez and Easter Island have been declared national parks. This gives effect, so far as Juan Fernandez is concerned, to a proposal which was first put forward so long ago as 1921. The two volcanic islands grouped together under the name Juan Fernandez and situated four and five hundred miles respectively west of Valparaiso are of popular interest because it was on one of them that Alexander Selkirk was marooned from 1704 until 1709; and his adventure is supposed to have inspired Defoe in writing "Robinson Crusoe". Easter Island, on the other hand, which lies about 2,300 miles from the mainland, is one of the most interesting islands of the Pacific. Its archæological remains present a problem for ethnologists which hitherto has defied satisfactory solution. These remains consist of more than five hundred human figures, portrait statues, carved in stone, some of gigantic size and one at least approaching forty feet in height, over two hundred stone platforms and stone houses, unique in the Pacific, relics of a race of which the present inhabitants have no knowledge. Even more interesting in certain respects are the tablets inscribed in a script which no one has yet succeeded in deciphering. Since 1888 the island, which has an area of about 48 square miles, has been in the possession of Chile, and has served as a penal settlement. The native inhabitants, who are Polynesians with a Melanesian strain, barely exceed 200 in number, though in 1860 they numbered 3,000; but in the 'seventies a considerable proportion migrated or was removed to Tahiti and the Gambier archipelago. The decree of the Chilean Government, in so far as it will ensure the protection from vandalism of these unique relics of an otherwise unknown culture and an apparently vanished race, is a public-spirited act worthy of the highest commendation.

A Tidal Power Project in the Bay of Fundy

THE Bay of Fundy is well known throughout the world for the height of its tides. It is not surprising, therefore, that Americans are interested in the

project for getting tidal power at Passamaquoddy Bay, which lies between New Brunswick, Canada, and Maine, U.S.A. A full description of the project is given by H. E. M. Kensit in *World Power* of February. The projected power house is situated entirely in the State of Maine, but as the project is an international one, the power produced would be equally divided between the two countries. If we compare the estimated cost of the new project with that of the corresponding tidal power schemes in England (the Severn) and in the Argentine (San José) it comes out decidedly cheaper. In the English scheme, the cost of a horse-power is £31·4, in the Argentine it is £25·3 and at Passamaquoddy it is £18·9, and each is roughly of the same size. The normal spring tides at the head of the Bay of Fundy range between 47 ft. and 52 ft. The maximum recorded tide occurred in 1869 and was nearly 57 ft. At the site of the new power station, the tides will lie between 17 ft. and 19·5 ft. In 1930, President Hoover induced Congress to defray half the cost of a joint investigation with Canada into the effect of such a station on fisheries. In this connexion, it is of interest to know that the committee on the Severn project decided that a large number of sluices open for many hours every day would obviate any detriment to fishing interests. It is probable therefore that the joint commission on fisheries may present a favourable report. The United States engineers indicate that there is no insuperable difficulty with regard to shipping interests, and many are hoping that this great enterprise will be carried out by private interests and capital.

Habits and Evolution

At the annual conference of the School Nature Study Union, held in January, Prof. E. W. MacBride was the speaker, and his address upon "The All-importance of the Study of Habits for the Knowledge of Evolution" was, in effect, a statement of his evolutionary faith (*School Nature Study*, 1935, p. 2). He led to his own viewpoint by a vigorous onslaught upon the faiths of others. Evolution we all accept, but the way thereof is dark. Darwin, we learn, with his natural selection of variations, was a false prophet, for natural selection does not work even if small deviations were heritable, which they are not. The mutationists are equally in error, for a mutation is a suddenly produced disturbance of development which persists only so long as the conditions producing it continue. According to Prof. MacBride, the truth lies with the neo-Lamarckians in their belief that use and disuse, in short habit, have been the mainspring of the progress of evolution. "Habit long persisted in does affect posterity and is the driving force in evolution; the personality, if we may use such a word, of a living being, is made up of a complex of inherited habits, and habits deeply ingrained are extraordinarily persistent." Prof. MacBride supports his thesis and trounces his opponents by quoting experimental results well selected for his purpose. Thirty years ago no biologist would have listened to the Lamarckian view; nowadays we are not so sure.

Scheme for Eradication of Cattle Tuberculosis

The Ministry of Agriculture and Fisheries has issued a document describing 'arrangements' made by the Ministry under Section 9 of the Milk Act, 1934, for promoting the establishment of cattle herds officially certified to be free from tuberculosis. Any owner who has taken steps to eradicate the disease from his herd, and is a 'registered producer' under the Milk Marketing Scheme, is entitled to apply to the Ministry for an official test of his herd, providing no reactors were found in the herd at the last two tests made under certain conditions on the owner's behalf. If the owner satisfies the Ministry as to the management and conditions of herd and farm, and agrees to observe the regulations, an official tuberculin test of the herd will be made by the Ministry free of charge, and provided no reactors are found, the herd will be placed upon a 'register of attested herds'. The scheme, which is a voluntary one, came into operation on February 1, and owners who desire to avail themselves of it should communicate with the Secretary, Ministry of Agriculture and Fisheries, Whitehall Place, London, S.W.1. One advantage of attestation is that the owner will be entitled to a bonus of 1*d*. per gallon for all milk sold under the marketing scheme of the Milk Marketing Board.

Iodine and the Thyroid Gland

In the twenty-ninth Bedson Lecture delivered on February 8 in Newcastle, Prof. C. R. Harington dealt with the relation of the thyroid gland to iodine. He traced in detail the parallel histories of the anatomy, physiology and pathology of the gland, culminating in the work of Kocher, the treatment with sheep gland extracts by Murray, and the iodine treatment by Coindet of goitre and cretinism. Although the 3 : 5-diiodotyrosine also present in the 'colloid' must take part in the activity, as this is proportional not to total thyroxine but to total iodine, the two dipeptides made from them have not proved to show the full activity, so that possibly they are linked to, or by, other amino-acids, it being fairly established that no other compound of iodine is present. The general picture, then, is as follows. Iodine is readily taken up by the gland with formation of 3 : 5-diiodotyrosine, which is elaborated into the globuline; this is the storage form, the so-called 'colloid', of the epithelial layer. When total iodine in the gland falls below 0·1 per cent, the colloid is soon exhausted and the epithelium extends to form goitre. Later, generally in pre-natal conditions, atrophy occurs leading to cretinism. Restoration of iodine at the former stage leads to distension by colloid, and the epithelium reabsorbs. In the normal state the tyrosine derivative is partly converted into thyroxine, and these two substances form the hormone which regulates bodily metabolism in general. In support of this view, it has been shown by Prof. Harington that the tyrosine and thyroxine are of the same stereochemical configuration by the preparation from each of thyronine (desiodothyroxin).

Ideal Home Exhibition

THE nineteenth *Daily Mail* Ideal Home Exhibition will open at Olympia, London, on March 26. A feature of the Grand Hall will be the great murals, 36 ft. high and 374 ft. long, from end to end of each side of the hall. The eighteen panels will bring to the eye, not only the vivid story of the changing world but also the actual features of more than a thousand men and women—pioneers, social workers, explorers, scientific workers, engineers, industrialists and others who have achieved distinction in helping to change the world for the better. This work has been carried out to the original designs of Oswald Cuningham. Among the features of the Exhibition will be a £50,000 installation of the very latest types of British-made canning machinery, weighing nearly 40 tons, to demonstrate the rapid strides made by this new home industry. Twenty-five years of progress in things engineering and scientific will be found on the second floor of the Empire Hall—the development of electric lighting, telephones, aviation, travel, transport, sound-recording, reproduction and radio. The General Post Office will have in operation the latest of the many wonderful machines utilised in modern communications. The strides made by 'staybrite' steel, which made its debut at the exhibition last year, will be demonstrated, and there will be numerous exhibits of beauty and utility for the home for furnishing, lighting, heating, decoration, labour-saving and recreation.

Improving Long-Distance Telephone Transmission

THE rapid improvement of the technique of radio communication during the last ten years is now having a beneficial influence in the development of long-distance telephone transmission. In particular, the improvements made in vacuum valves due to the demands made by broadcasting engineers have led directly to great improvements in the design of the repeater valves used in long-distance telephony. It is well known that during conversation over long lines by means of carrier frequency equipment the sounds heard sometimes vary greatly in loudness. This is attributed to the fact that the attenuation of the line, especially when overhead wires are used, changes with climatic conditions, temperature, etc. With cable circuits, the loudness remains much more constant. The phenomenon is analogous to the well-known phenomenon of 'fading' in radio transmission. Successful attempts have recently been made to mitigate this trouble. A paper by H. Sterky and R. Stalemark which appears in *Ericsson Technics*, No. 3, 1934, describes an automatic method of compensating for these variations which has been used in practice for the last two years with good results. The development of the method is due to the telephone firm of Ericsson, Stockholm. It depends on the well-known mathematical theorem that a carrier wave modulated by a wave of voice frequency is equivalent to three separate simultaneous oscillations. One of these has the frequency of the carrier wave; the others, called side-band waves, are of higher and lower frequency respectively. In the Ericsson device, during conversation, the carrier and one side-band wave are transmitted. Signalling is done by modulating the carrying wave with the 'ringing' current. It is stated that the volume control of the sound obtained in this way is very good.

Shellfish and the Public Health

THE Minister of Health has issued an Order, Public Health (Shell-fish) Regulations, 1934, revoking previous regulations, and regulating the sale of shellfish for human consumption, which came into operation on January 1. The new regulations give powers to local authorities to investigate suspected layings, to prohibit the sale of shellfish from polluted layings, and to provide cleansing apparatus if considered necessary (Statutory Rules and Orders, 1934, No. 1342. 2*d*. Circular 1446. 1*d*. H.M. Stationery Office).

International Office for the Protection of Nature

THE Belgian Government has by Royal decree officially recognised the International Office for the Protection of Nature, Rue Montoyer 21, Brussels, and has appointed the following delegates to be its representatives on the General Council of the Office: Delegates for Belgium, Baron E. de Cartier de Marchienne, Belgian Ambassador in London, and Count Henry Carton de Wiart, former Prime Minister; Delegates for the Belgian Congo and the Mandated Territory of Ruanda-Urundi, P. Charles, Minister of Colonies, and Prof. V. Van Straelen, director of the Royal Belgian Museum of Natural History and president of the Institute for National Parks in the Belgian Congo.

Oxidation-Reduction Potentials in Bacteriology

THE fact that a second edition of Dr. L. F. Hewitt's monograph on "Oxidation-Reduction Potentials" has been found necessary indicates the interest taken by biologists in the subject ("Oxidation-Reduction Potentials in Bacteriology and Biochemistry": published by the London County Council. Pp. 81. 2*s*.). Since the first edition was noticed in our columns (NATURE, **128**, 73; 1931) the subject has advanced steadily, and the author has taken the opportunity to revise and extend the text and bring the bibliography up to date. The study of electrode potentials is proving of assistance in the practical question of the rationalisation of culture media and cultural conditions, and is throwing light upon the biological behaviour of organisms, such as the maintenance or loss of virulence, questions of great importance in medical practice.

Improvement of Grassland

As much as eighteen million acres in England and Wales consists of grassland, and considerable attention has been paid in recent years to its improvement. The need for authoritative information on this important subject led to the publication of Bulletin No. 3, "The Improvement of Grassland", by the Ministry of Agriculture and Fisheries, a fourth and revised edition of which has been issued (1*s*. net). The revision of the text has largely been carried out by Prof. J. A. Hanley (Armstrong College, Newcastle-

upon-Tyne) who has taken the opportunity of incorporating in the present issue the deductions drawn from the work done under the Ministry's 'Grassland Campaign', and also to include a section on the comparatively new system of rotational or 'managed' grazing. The sections on the renovation of worn-out grassland and seed-sowing remain substantially as written by Prof. R. G. Stapledon, of the Plant Breeding Station, Aberystwyth.

Medical Research in South Africa

THE annual report by the director, Sir Spencer Lister, of the South African Institute for Medical Research, Johannesburg, gives an account of the routine and research work of the Institute for the year 1933. Concentrated anti-plague serum, prepared in the Serum Department, has been tested experimentally, and has been found to have four times the protective and curative power of the unconcentrated serum, concentration being in the same ratio. Considerable difficulty has been experienced in maintaining the virulence of the plague bacillus in culture, and this difficulty has not yet been overcome. The study of pneumonia as it occurs among native miners of the Witwatersrand goldfields was continued, and the work confirms previous findings that the disease is not a pure pneumococcus pneumonia of the earlier days of the Rand, but that other organisms are associated with, or replace, the pneumococcus, namely, the streptococcus, staphylococcus and influenza bacillus. During the year, a case of human rabies due to a cat bite was observed; the incidence of human rabies infection is on the increase in South Africa, being conveyed by the cat, the tame meercat, and occasionally the dog. The observations upon dust estimation and control in the mines have been extended, and research upon several other subjects has been continued.

Astronomical Phenomena in March

MERCURY is now a morning object, and attains its greatest elongation of 28° W. on March 15. Venus, on the other hand, is moving round to its greatest eastern elongation (45° E. on June 30) and has already become a conspicuous object in the evening sky just after sunset. Mars is well placed for observation, being very nearly in opposition. Jupiter is a morning object, and Saturn is very near the sun. An interesting conjunction of Venus and Uranus will occur on March 22 at 7 hours, when the planets will only be separated by 0·4°. This conjunction will, of course, be invisible in England, but the two planets should be seen close together, in a small telescope, on the evening of March 21 or of March 22. Neptune is well placed for telescopic observation, being in opposition to the sun on March 4.

Announcements

PROF. W. J. DE HAAS, University of Leyden, informs us by cable that on February 15 he succeeded in reaching a temperature only five thousandths (0·005) of a degree above absolute zero. Particulars of this remarkable achievement will be awaited with great interest.

AT the annual meeting of the Royal Society for the Protection of Birds to be held at the Westminster Palace Rooms, 44 Victoria Street, S.W.1, on Friday, March 1, Her Grace the Duchess of Portland, president of the Society, in the chair, a motion will be submitted "That the Governments of all maritime nations be urged to give the strongest possible support to the League of Nations in their endeavours to secure the universal adoption of effective measures for preventing the pollution of the seas by oil".

IT is proposed to hold an exhibition of English periodicals and reviews in the library of the University of Coimbra, Portugal, early this year. It is hoped later to transfer the exhibition to Lisbon, Oporto and Braga. It appears that English is the second foreign language in Portugal, and a large proportion of its inhabitants have a working knowledge of the language; but there is a general ignorance of what periodicals and reviews are published in English. It is hoped that the exhibition will remedy this state of affairs. Further information can be obtained from the Director, Biblioteca da Universidade, Coimbra, Portugal.

REFERRING to Mr. C. R. Cosens's letter in NATURE of January 12 (p. 71) on "Designation of Logarithms to Base e", Dr. J. Satterly, of the University of Toronto, writes: "Long ago I decided that log$_h$ was too long and log$_{10}$ and log$_e$ awkward and have recently designated for blackboard work common logarithms and natural logarithms as 'ln' and 'le', pronounced something like 'Ellen' and 'Elsie' respectively."

A BOOKLET dealing with the chloramine group of antiseptics has been issued by Boots Pure Drug Co., Ltd., Station Street, Nottingham, from whom it may be obtained free of charge. Attention is directed to the use of 'chloramine-T' and 'dichloramine-T' in the treatment of infected wounds, and to 'halazone', a most satisfactory chlorine compound for the sterilisation of drinking water.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A computer (class II) to the Ordnance Committee, Royal Arsenal, Woolwich, S.E.18—The Secretary (Feb. 25). A lecturer in electrical engineering at Chesterfield Technical College—The Director of Education, County Education Office, St. Mary's Gate, Derby (Feb. 25). A University lecturer and a part-time University lecturer in the Faculty of Mathematics, University of Cambridge—The Secretary to the Faculty Board of Mathematics, St. John's College, Cambridge (March 2). Junior scientific officers in the Aerodynamics and Radio Departments of the National Physical Laboratory, Teddington—The Director (March 4). A resident lecturer (chemistry or physics) at Girton College, Cambridge (March 6). An assistant lecturer in zoology in the University of Bristol—The Secretary (March 11). A Henry George Plimmer fellowship in pathology at the Imperial College of Science and Technology, Prince Consort Road, London, S.W.7—The Rector (June 17).

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 310.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Deep Diathermic Effect and Localisation by Means of 'Auxiliary Dielectric Electrodes' in the Condenser Field

AT present it is impossible to heat the deeper parts of a body of uniform transverse section and homogeneous structure to a higher temperature than its peripheral parts by means of high-frequency currents. With present-day methods the loss of oscillating energy by leakage and radiation is so great that probably less than 20 per cent of it is used for heating effects. Further, it is impossible to localise, to concentrate or even to direct the field more than very vaguely. Any object brought into the field deforms it in an uncontrollable way.

I have found a method by which the condenser field can be made to produce a greater effect at the deeper parts than at the peripheral parts by the use of 'auxiliary dielectric electrodes'. Between the two metal plates, of 2–3 in. diameter, of the high-frequency apparatus is placed a glass tube, about 4 in. long and half an inch in diameter. Near one end is a side tube for filling. The ends are closed by flat glass walls. An air space of $\frac{1}{4}$ in. is interposed between the metal electrodes and the glass ends. The tube is filled with white of egg. On exposure to the field, coagulation commences at the middle of the tube and gradually extends towards the ends, which remain cool. The coagulation does not occur if the long axis of the tube is parallel to the electrodes. If in this position suitable cylindrical auxiliary dielectric electrodes, one to two inches in diameter, made of agar, wax, ebonite, etc., be placed so as to occupy the space between the metal electrodes and the tube and be in contact with electrodes and tube, then coagulation occurs in that part of the tube which lies between the auxiliary electrodes. If we arrange the tube again lengthwise and apply a short dielectric cylinder to one end, a longer one to the other, the point of coagulation will be moved towards the longer dielectric. Different shape or different material of one dielectric may modify this effect.

A similar experiment can be performed with minced muscle, liver, kidney, etc. In some experiments it was possible to heat a 580 gm. piece of ox-liver to a considerably higher temperature in the centre than at the borders. For example, thermometers 0·6 in. from each side, and a thermometer in the middle and so 2·5 in. from the sides, registered as follows :

	Left edge	Centre	Right edge
Starting temperature	12°	9°	11°
After 10 minutes	15·8°	15·6°	15°

At this time the temperatures throughout the piece might be considered as equal. The room temperature was 18·5°. The following temperatures were reached :

After 10 minutes	19·6°	23·3°	18·3°
After a total of 60 minutes	31·7°	40·7°	31·2°
Total rise	19·7°	31·7°	20·2°

Of course, in the living animal such differences will scarcely be obtainable, except in quite special circumstances, on account of the considerable heat convection by the circulating blood and lymph. The effect is nearly the same for any wave-length between 3 and 30 metres.

These experiments prove the possibility of deep-heating, of localising and of concentrating the lines of force and of directing the field. A further advantage is the considerable reduction of the losses by leakage and radiation ; the loss in the dielectric itself depends on its transparency for these waves.

Differences in the size of cross-sections of different parts of the object cause an increased heating-effect on the site of the smallest sections, and prominent points or corners sometimes heat up quickly. This inconvenience can be overcome by moulding the dielectric substance around or partly around the smaller cross-sections, so that they are artificially increased. In that way it is possible to heat equally through a cross-section situated anywhere by leaving this section free and moulding dielectric substance round the other parts of the object. This produces a localised heating of the whole section, for example, an elbow or a knee.

The greatest difficulty in human application is the apparent necessity of electrodes of bigger size than the object. Not only is the relation of the size of the electrodes to the object important, but also the relation between the length of the object to its cross-sections. This can be corrected to a great extent by suitably shaped auxiliary electrodes. Recent experiments seem to show that it is sufficient if one electrode only is bigger ; and if one does not wish to reach a higher temperature in the centre than near the surface, then two small electrodes are sufficient for a practically equal heating.

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Jan. 16.

Well Gauges as Seismographs

A NUMBER of workers[1] have noted that distant earthquakes are registered on automatic water stage recorders operated on deep wells. In each of these cases, the time scale was so small that the earthquake record was merely a thick line transverse to the direction of time movement. We recently fixed a gauge in a well at Lodi, California, with a Bosch-Omori seismograph drum, rate 15 mm./min., and smoked paper recording. The well is known as 3612A2. It is located at lat. 38° 07′ 38″ N., long. 121° 16′ 29″ W. in the Mokelumne area of the San Joaquin Valley. It is of circular cross section, diameter 6 in., depth 76·0 ft. below ground surface which is at an altitude of 46·9 ft. above mean sea-level. This well, which is not cased below the water surface, is in unconsolidated alluvial deposits of

Pleistocene and Pliocene age. It presumably penetrates to a confined aquifer or aquifers. No log is available. The gauge is composed of a copper float, 4½ in. in diameter, which operates a stationary 8 in. float-wheel by means of a cord and counterweight. A 4-in. diameter axle mounted on the float-wheel shaft is connected at its upper periphery by a copper ribbon to an auxiliary wheel in the same plane and at the same elevation, on the other side of the recording drum, tension in the ribbon being maintained by a second counterweight below the auxiliary wheel. An aluminium stylus attached to the copper ribbon thus moves horizontally a distance equal to one half that which the float moves vertically. This stylus records on smoked paper on the drum. The minutes are marked on the record by means of a pendulum contact-making clock (supplied by Spindler and Hoyer with Bosch-Omori seismographs), actuating a relay circuit coupled to a solenoid, which energises the magnetic counterweight. Thus the stylus is displaced each minute. The clock correction is obtained daily.

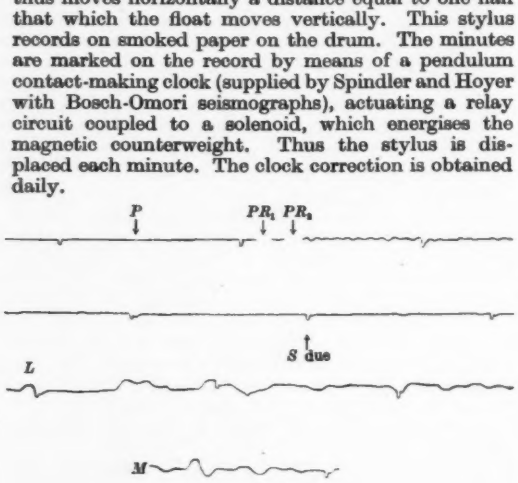

FIG. 1.

On November 30, 1934, at about $2^h\ 05^m\ 12^s$, G.M.T., an earthquake occurred with epicentre at 18·5° N., 105° W., as placed by the Jesuit Seismological Association. This was the first shock to be well recorded on the Lodi well gauge. The record is reproduced in Fig. 1. The epicentral distance of Lodi was about 25°. The *P* phases were all recorded, the reflections PR_1 and PR_2 particularly well. The *S* waves were not distinguishable. At the Berkeley station (epicentral distance 25°) the Bosch-Omori seismographs (static magnification 40) wrote an excellent record of this shock. The amplitudes of the *S* waves were about four times those of the *P* waves. Some workers have hesitated to say definitely that the second preliminary or *S* wave is a shear wave. It appears that its failure to record on the well-gauge establishes definitely that it is an equivoluminal wave, since it is to be expected that only waves involving change in volume, and hence hydrostatic pressure, will affect the water-level. More sensitive recording apparatus may eventually reveal some small motion when *S* is expected due to the surface reflection of some of the *S* energy as *P* waves.

The surface waves are well marked on the record. These begin with the wave tabulated as *L* by Macelwane in his table. It has been clear for some time that this wave is not a Love wave since it has usually a vertical component. The recording of it on a device not sensitive to shear waves confirms this. The Love wave is regularly recognised on seismograms much earlier and is now frequently called *G*. It appears possible to recognise a later group of waves resembling the *M* waves on many seismograms. Although not usually tabulated, there are three groups of seismic surface waves: *G* (Love waves), *L* and *M*. Only the latter two were recognised on the well record.

The appended table gives the observed and computed times of the various groups of waves. The maximum half amplitude on the record was 0·8 mm.

Phase	Observed Time	Computed Time
P	$2^h\ 10^m\ 36^s$	$2^h\ 10^m\ 37^s$
PR_1	11 16	11 10
PR_2	28	23
L	17 02	17·4
M	20 21	19·8

We wish to acknowledge the assistance given by Mr. Theodore Netland.

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[1] H. T. Stearns, Bull. 18, Seis. Soc. Amer., pp. 9–15, March, 1928; S. B. Morris, paper read before a meeting of Seismological Society of America, Los Angeles, April 8, 1933; A. M. Piper, *Trans. Amer. Geophys. Union*, April, 1933 meeting, pp. 471–475; R. M. Leggette and G. H. Taylor, *Earthquake Notes*, **6**, pp. 16, 17, September, 1934.

Sedimentation Equilibrium Measurements with Low Molecular Substances in the Ultra-Centrifuge

IN a recent paper[1] I have shown that it is possible to study the sedimentation equilibrium of the heavier inorganic salts (for example, CsCl, CsI, KIO_3, $LiIO_3$, $HgCl_2$ and others in 0·1 molar solutions) in the ultra-centrifuge of The Svedberg[2]. These experiments were carried out in a centrifugal field of about 200,000 times gravity. By means of a refractometric method worked out by O. Lamm[3] it was possible to study the change in concentration in the cell. From the variation of the concentration set up by these intense centrifugal fields with the distance from the axis of rotation, the molecular weight of the substance may be calculated when the speed of the centrifuge and the temperature of the cell are known. In addition, it is necessary to know the density of the solution and the partial specific volume and activity coefficient of the substance in solutions of like concentrations.

The calculated molecular weights agreed fairly well with the known values for these substances except in the cases of the substance with the lowest molecular weight, CsCl, where the difference in concentration was very small.

Quite recently, Prof. Svedberg has greatly improved his ultra-centrifuge (see Svedberg, *loc. cit.*), and in October last a new rotor of a somewhat different construction from that already described in NATURE was tested at 155,000 r.p.m. and was ready for general work up to a speed of 140,000 r.p.m., corresponding to a centrifugal field of 710,000 times gravity in the middle of the cell. Although the cell for this rotor was not especially constructed for equilibrium experiments, it was decided to try to use it in this way with low molecular substances, at a speed of 120,000 r.p.m., corresponding to a centrifugal field of 525,000 times gravity. At once it became clear that the difficulties in such high fields were very much larger, because the cell was deformed continuously. However, it was possible to diminish

the influence of this deformation on the measurements by making alternate experiments with pure water (for the reference scale, for details see Pedersen, *loc. cit.*) and the salt solution. In this manner we are able to relate values for a certain run to the run immediately before and immediately after it (each run took 6–8 hours).

By using this procedure there could be measured the change in concentration in the cell for such low molecular weight substances as NaCl, LiCl and the simplest amino acid (glycocoll). The molecular weights found were: for NaCl 57·4 (58·454), for LiCl 37·8 (42·397) and for glycocoll 68·1 (75·05). The values in parenthesis give the true molecular weights. This result means that it is actually possible by means of the ultra-centrifuge to determine the molecular weight of all substances (soluble to a certain extent in water) from LiCl up to the huge hæmocyanine molecules (molecular weight 6,000,000).

The experimental difficulties connected with the gradual deformation of the cell we hope to be able to overcome by introducing certain alterations in its construction.

The calculations of these experiments were carried out in a somewhat different way from that used before[1], introducing the refractive index increment of the substance. Assuming that the same total amount of substance is present in solution in the cell when the equilibrium is established as at the start, it is possible by means of an integration method to determine the concentration of the substance at any point of the cell, and after this the molecular weight may be calculated either in the usual way or by introducing the value found for dc/dx in the differential formula for the molecular weight.

Details will be published elsewhere.

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Dec. 22.

[1] Kai O. Pedersen, *Z. phys. Chem.*, A, **170**, 41; 1934.
[2] The Svedberg, G. Boestad and I.-B. Eriksson-Quensel, NATURE, **134**, 98; 1934.
[3] Ole Lamm, *Z. phys. Chem.*, A, **138**, 313; 1928. **143**, 177; 1929.

Use of the Centrifuge in Determining the Density of Small Crystals

IN a previous letter[1] we described a method of determining the density of small crystals of a substance with the centrifuge for the purpose of determining its molecular weight. It has since been brought to our notice that essentially the same method has been used by S. B. Hendricks[2] though with a different object. We should, therefore, like to correct the impression that we claim any novelty for this method of density-determination, while still wishing to point out its usefulness as a method of determining molecular weights to a high degree of accuracy.

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D. CROWFOOT.

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[1] NATURE, **134**, 809; 1934.
[2] *J. Opt. Soc. Amer.*, **23**, 299; 1933.

Mechanism of Respiration

THE respiration of the minced breast muscle of the pigeon has been studied by means of specific poisons (malonic, maleic and arsenious acid). Experiments show that in the main process of respiration, no substances other than succinic acid and its first oxidation product, fumaric acid and the hydrate of the latter, malic acid, are oxidised directly by the Warburg-Keilin 'Atmungsferment-Cytochrom' system. Both succinic and malic acids are activated by the corresponding specific dehydrogenase. Only these two dehydrogenases seem to be connected immediately with the Warburg-Keilin system. Succinic acid is oxidised by them to fumaric, malic to hydroxyfumaric acid. Both oxidations are reversible.

Foodstuffs are oxidised by dismutating them with oxidation products of succinic acid, which products thereby become re-reduced and act thus as catalytic hydrogen carriers. The 'oxidation system' is an enzyme complex acting specifically on succinic acid and its oxidation products. Fermentation is an intramolecular dismutation. Oxidation is dismutation with oxidised succinic acid.

This research has been sponsored by the Josiah Macy, Jr., Foundation, New York.

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Jan. 26.

Cosmical Chemistry

MANY will read with interest and admiration Prof. H. N. Russell's fascinating and masterly address published as a supplement to NATURE of February 9; it is all that an address should be on such an occasion. Having watched the story of ultramundane chemistry unfold from all but its Bunsen and Kirchoff-Stokes beginning, especially during the turbulent Lockyer period, I perhaps can appreciate both its beauty and the greatness of our advance in knowledge more than most, so may be allowed to tender to Prof. Russell the thanks that so many, I am sure, will wish to express.

What would the founder and first editor of NATURE have said to the use made of the spectroscope since he turned his instrument to the sun and discovered helium, the only element discovered in the sun, perhaps some day, when we draw pictures of atomic structure as we now do of molecular, to be recognised as the fundamental element as benzene is the fundamental carbohydride? The wave of enthusiasm then excited has rolled on with ever increasing amplitude and certainty of direction.

The cosmos stands revealed before us, in wondrous simplicity too. Even organic chemistry is lifted up to the stars and shown to have the simplest possible beginning there in methane, together with ammonia. Some planets, it seems, may be worlds of Franklin chemistry; with ammonia as snow.

We are in face of a transcendent geology but whilst readers of NATURE may geologise on Mars and recognise ferric red on its surface rocks, few of our schools pay the least attention to mundane geology. Dust has no ethics in most eyes: our women wear it but without understanding. Love of colour is a barbaric trait—understanding is not. Are the masses ever to remain barbarians? What is to be the use of leisure in the future? At least, we should seek to civilise our politicians and all who strive to

put themselves in authority over us: the freedom to display ignorance granted to these, as at Wavertree these last few weeks, is nothing short of a menace to society.

Still, the physicians have to heal themselves. When, fifty years ago, I began to teach my engineering students at the 'Central' to look chalk in the face, in the hope of leading them to take some slight interest in geology, I had the beautifully coloured large Geological Survey map of our islands, made by joining the separate sheets, pasted upon the wall, on the stairway leading to the laboratory, varnished and framed; it was there until I left in 1914. I made the class buy the key map of the Survey and Charles Kingsley's lectures on "Town Geology", advising students to hang the map up in their bedrooms. Looking for the map at the jubilee celebration, at the 'Central', this week, I found the wall reduced to the condition of the map bought by the 'brave Captain' in "The Hunting of the Snark"—a perfect and absolute blank! Modern professors of engineering have no use for geology; their hearts are so encased in steel that they no longer see anything in stones. A like map has reigned at the head of the stairway to the large science workshops at Christ's Hospital since the school was opened at Horsham more than thirty years ago. I expect soon to see its place taken by School Certificates. Geology is only brought before us to-day by the saving grace of the railway poster.

HENRY E. ARMSTRONG.

Feb. 9.

Wasting Disease of *Zostera marina*

IN Dr. Kathleen B. Blackburn's letter on this subject[1], the conclusion seems well established, through a study of the chromosomes, that the narrow-leaved form of the eelgrass (grass wrack), which has in many of the diseased areas replaced the larger and broader type of plant, is clearly a form of *Z. marina* and not a hybrid of *Z. marina* and *Z. nana*, as some have believed. Miss Blackburn therefore suggests that the difference in the width of the leaves of varieties of *Z. marina* may be a purely ecological character. She further remarks that, in the localities examined, the width of the leaf of *Z. marina* was directly proportional to the depth of the water, and that the very narrow-leaved forms were those that had been longest exposed by the fall of the tide, while the broader were those that had not been exposed at all.

It may be of interest to report that on the American coast the evidence does not entirely support this ecological interpretation. *Zostera marina* is the only species recognised as occurring on this side of the Atlantic, and it extends from southern Labrador (with outlying stations in southern Greenland and in James Bay) southward to a point near the city of Beaufort, North Carolina. In travelling from north to south, one notices a gradual and progressive reduction in the size of the plant and in the width of the leaf blade. Leaves from plants found in northern Maine, for example, are often more than three times the width of those from Pamlico Sound, North Carolina. The diameter of the rhizomes likewise undergoes reduction southward, and there is an accompanying reduction in the number of leaf veins.

Dr. Setchell, in his excellent paper, "Morphological and Phenological Notes on *Zostera marina* L."[2], does not specifically state that the plants in their first year of growth are smaller and have narrower leaves than in the more mature stages, although he seems to demonstrate this in his illustration of stages in the growth of plants. From observation of *Z. marina* in places where it has begun to re-establish itself along the Atlantic coast from Maine to North Carolina, there is ample evidence of this habit of growth. In many such places the plant has shown some slight evidence of recovery, and wherever examined, the new growth has been found more slender than in the mature plants.

At a point on the coast of eastern Maine where the average tide fluctuation is nearly 18 ft., I found eelgrass growing in more than 10 ft. of water at mean low tide. The plants here were narrower than in those that appeared to be of the same age growing in shallower water. It does not seem, therefore, that the depth at which the plant grows always is positively correlated with breadth of leaf.

The observed characters of *Zostera marina* on the Atlantic coast of North America would seem to indicate that robustness is correlated with both temperature and age of the plant, the northern forms of a given age being larger and having broader leaves than those from farther south. Perhaps the length of the growing season may be an important factor in this regard. Setchell shows that vegetative growth of this species takes place when the water temperature is 10°–20° C., while reproduction occurs only between the temperatures of 15° and 20° C. According to the same author, no growth or reproduction takes place when the temperature is either above or below these limits or during the period when the temperature is declining from 20° to 10° C., which he calls recrudescent rigor. Thus, there is a shorter growing season in extreme southern latitudes than in most of the northern areas of the plant's normal range.

Among local factors that frequently influence the development of submerged aquatics may be mentioned water currents, temperature, the condition of the bottom, particularly in regard to type and texture of soil, and the chemical composition of the water, especially in relation to fluctuation of salinity of tide water sections of coastal river systems. My own observations seem to show that the general vigour of *Zostera marina* is lessened in areas of greatly reduced salinity, and that at such places the leaf is comparatively narrow. The above and other factors are to be considered in any interpretation of the causes of abnormal leaf development.

It is conceivable that, in some circumstances, as in British waters, the plants might be stimulated by depth to produce broad leaves, yet this does not seem to be typical of conditions on the American coast.

CLARENCE COTTAM.

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Bureau of Biological Survey,
Washington, D.C.
Dec. 21.

[1] NATURE, **134**, 738; 1934.
[2] *Univ. Calif. Publ. Bot.*, **14**, No. 19, 389–452; 1929.

Germination of Resting Spores of Onion Mildew (*Peronospora Schleideni*)

IN spite of the ubiquity of the Peronosporas and the frequent occurrence of sexually produced spores amongst the various species, very little is known in regard to the ultimate fate and method of germination of such oospores. Several workers have recently commented on this fact.

In a previous publication[1] attention was directed to the failure to germinate resting spores of *Peronospora Schleideni* in the laboratory, even when subjected to different treatments. The peculiar germination of one untreated spore, kept in a sealed moist chamber for several months, was mentioned in the same paper. Since then, the germination of a number of resting spores of this fungus has been seen under more natural conditions.

In the year 1930, I found a crop of onions in which enormous numbers of resting spores of onion mildew were being produced in the foliage. A sack-full of these leaves was collected and taken home, being then trampled into a large box provided with holes at the bottom for drainage. Bacterial action soon commenced and the leaves went down into a vile-smelling mess, which after the lapse of a few weeks dried up, leaving a fine material a couple of inches deep in the box consisting of decayed leaf tissue and abundance of resting spores. The box has remained fully exposed in a garden since then, and periodically, a little of the fine material has been removed in order to photograph any change occurring in the spores, and also to test for germination. The collapsed oogonium is remarkably persistent, and forms an additional protective layer 2–3μ in thickness around the thick spore wall.

Little or no change was seen in the spores until they were three years old, when it was found that in some cases the oogonium had disappeared wholly or in part, and the spore wall had thinned down to 2–1μ. Germination of an odd spore was obtained at the end of four years, and after a further five months, on placing some of the material from the box in water in a warm room, approximately 1 per cent of the spores germinated after eleven days, a total of twenty-seven being observed. Germination in all cases was by a stout germ-tube 6–9μ in diameter, which was capable of considerable growth in water, up to 960μ. In a number of cases this germ-tube branched. Spores which were partly free from the oogonium and germinated were of a light straw colour; in some instances the germ-tube pushed its way out through the enveloping folds of the persistent oogonium. Whilst thinning of the spore wall has taken place in quite a considerable number of the spores, others show no visible change from those photographed at the end of the first year, and judging from their appearance they are probably good for another five years.

So far as I am aware, the above is the only record of the germination of resting spores of onion mildew.

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Drumcondra,
Dublin.
Jan. 15.

ROBERT MCKAY.

[1] Murphy, Paul A., and McKay, Robert, *J. Dept. Lands and Agric. Dublin*, **31**, 59–76; 1932.

Crystallisation of Human Serum Albumin

APART from Oswald's report[1] that he had obtained globuliths from the albumin fraction of human ascitic fluid, we have been unable to find any account of the crystallisation of human serum albumin. Recently we have succeeded in obtaining albumin crystals from two separate batches of pooled human sera.

Serum was separated from the clot, heated for 25 minutes at 56° C. and fractionated within two or three days of bleeding. After addition of an equal volume of saturated ammonium sulphate and removal of the globulin, crystallisation was brought about by adding normal acetic acid. The requisite amount was first determined for 5 c.c. portions, acid being added from a micro-burette until the first faint permanent turbidity was observed; about 0·21 c.c. were required. Whereas crystals of horse serum albumin usually appear within two hours of acidification under these conditions, we were unable to detect crystals in our preparations of human albumin before the following day. Our experience has indicated that crystallisation of human albumin takes place within narrower limits of hydrogen ion concentration than is the case with horse serum albumin.

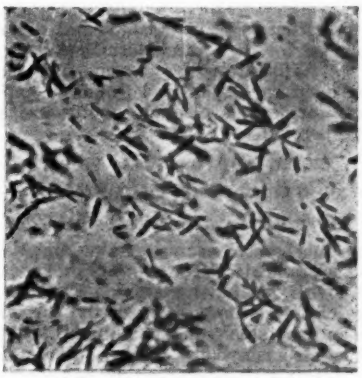

FIG. 1. Crystals of human serum albumin. ×540.

The main bulk of the protein solution was treated by adding slowly the calculated amount of acetic acid. After well-defined crystals had formed, the yield was increased by addition of a further amount of acid—half the volume of that first used. Two or three hours later a third addition of acid, equal to the second quantity, was made. The following day the crystals were collected by filtration.

The crystals obtained were readily visible under the 1/6 power of the microscope as small fine needles (Fig. 1). As in the case of horse serum albumin, the crystals dissolved in water to give an opalescent solution which was clarified by filtration, the turbidity being apparently due to lipid associated with the protein.

5 gm. of crystalline albumin was obtained from 300 c.c. of serum, representing a yield of about 40 per cent of its albumin content. Recrystallisation can be brought about by the method described by Adair and Robinson[2].

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Jan. 8.

[1] *Z. physiol. Chem.*, **95**, 102; 1915.
[2] *Biochem. J.*, **24**, 993; 1930.

Stability of the Acetyl Radical

IT is usually supposed that free acyl radicals do not survive the shock of thermal or photo-dissociation of the molecule from which they might be formed or, if formed, decompose further before they can react with other molecules to give rise to isolable products. Thus Rice has shown that no diacetyl results from the thermal decomposition of acetaldehyde[1], and Norrish has concluded as a result of his studies of

the decomposition of aldehydes and ketones that both of the bonds between the carbonyl group and the two groups attached to it are broken practically simultaneously, the two groups then, in general, uniting to form a saturated paraffin[3].

During an investigation of the photo-decomposition of di-ethyl-peroxide, we have found that the chief products are ethyl alcohol and a greenish-yellow substance which has been finally determined to be diacetyl. Little if any acetaldehyde was produced, at any rate during the early stages of the decomposition. The decomposition was very slow, and although no measurements of the quantum yield have been attempted, a chain reaction would seem improbable.

The formation of ethyl alcohol and diacetyl can be accounted for by a mechanism based on that of Haber and Willstätter[3] for enzyme oxidations and also employed by Taylor and Gould to explain the oxidation of ethyl alcohol photo-sensitised by hydrogen peroxide[4];

$$CH_3.CH_2-O-O-CH_2CH_3+h\nu \rightarrow 2CH_3.CH_2.O-$$

$$CH_3.CH_2.O- + CH_3CH_2-O-O-CH_2CH_3 \rightarrow 2C_2H_5OH+CH_3\dot{C}O$$

$$2CH_3\dot{C}O \rightarrow (CH_3CO)_2.$$

Such a mechanism necessitates a somewhat long-lived acetyl radical. In order to obtain further evidence for this, we have examined the non-gaseous products of the decomposition of the three simplest ketones and acetaldehyde. In all cases the products were of a greenish-yellow colour, which was, however, only faint with diethyl-ketone and acetaldehyde.

The products from acetone and methylethyl-ketone yielded with dinitro-phenylhydrazine a few milligrams of a substance almost insoluble in boiling alcohol (and therefore readily separable from the ketone derivative) but which could be recrystallised from pyridine. A derivative with similar solubilities was also obtained from the acetone product with mono-nitro-phenylhydrazine. In all cases the physical properties of these derivatives agreed with those of the corresponding derivative of diacetyl. Damon and Daniels have also observed that the liquid products from the photo-decomposition of acetone are coloured.

While far from being conclusive, this evidence would seem strongly to suggest that the acetyl radical is much more stable than is usually assumed, and that it possibly plays a significant rôle in the photo-decomposition of acetaldehyde and acetone at room temperature.

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[1] F. O. Rice, *Trans. Far. Soc.*, **30**, 168; 1934.
[2] Kirkbride and Norrish, idem., **27**, 407; 1931.
[3] Haber and Willstätter, *Ber.*, **64**, 2844; 1931.
[4] Taylor and Gould, *J. Phys. Chem.*, **37**, 367; 1933.
[5] Damon and Daniels, *J. Am. Chem. Soc.*, **55**, 2370; 1933.

Diffusion of Gases through Metals

I HAVE read with interest the letter by Dr. Smithells and Mr. Ransley on the diffusion of gases through metals in NATURE of November 24. I agree with them that diffusion is dependent on the solubility of gases in metals, and that the approximate proportionality to $\sqrt{P}$ is related to the fact that sorbed hydrogen is not only monatomic, but also ionised, as pointed out by me[1] and by A. Coehn[2]. Further, adsorption on the surface must be distinct from absorption within the metal. Absorption must be considered in the study of diffusion, just as Fourier and Poisson took account of specific heat in their classical equations for thermal conductivity.

In occlusion and diffusion, the hydrogen is in the form of protons (or deutons). I think the condensation of molecules on the metal surface, due to electrostatic attraction, produces electronic perturbations in the surface metal atoms (as shown by the effect on the photo-electric properties), which facilitates the diffusion of the gas. The effect of the adsorbed film can therefore only extend to a distance of one atomic diameter, and the mobility of protons within the metal will not depend on adsorption, but on the particular atomic arrangement of the metal and on the concentration gradient of absorbed hydrogen.

An equilibrium exists between the adsorbed gas and the gas absorbed near the surface, in which the two concentrations have a fixed ratio for each gas-metal system. Diffusion therefore depends on many factors. The proportionality between diffusion and $\sqrt{P}$ can be readily interpreted theoretically. The deviation from this law can be tentatively explained either by assuming an adsorption pressure threshold on one side and an evaporation pressure threshold on the other side of the metal; or alternatively, as suggested by Smithells and Ransley. The hypothesis can be tested by considering the behaviour of palladium towards hydrogen and deuterium.

From experiments which are still proceeding and will be published elsewhere, I have been able to show that palladium adsorbs deuterium very considerably from a mixture of hydrogen and deuterium, whereas it is well known that deuterium diffuses very slowly, in comparison with hydrogen, through palladium.

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R. Università,
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Dec. 15.

[1] T. Franzini, *Rend. R. Ist. Lomb.*, 709; 1931. *N. Cim.*, No. 9; 1931.
[2] A. Coehn, *Z. Phys.*, **62**, 1; 1930. **71**, 79; 1931. **83**, 291; 1933.

Molecular Spectrum of Cadmium Vapour

IN a recent article on the above subject, S. Winston Cram[1] has reported his inability to obtain, either in fluorescence or by excitation with a Tesla coil, a narrow diffuse cadmium band at 2212. He concludes that the band in that region which I obtained some years ago[2], using a pure electrodeless discharge in low pressure vapour, must be due to an impurity.

During a year's leave of absence, when working in the astrophysics laboratory of the Imperial College of Science and Technology, I made a careful examination of the molecular spectrum of cadmium. Although a full account of this work will be published later, in this letter I should like to direct attention to the following results relating to the origin of the band in question.

(1) As is shown by the spectra reproduced in Fig. 1, an arc between cadmium electrodes emits a band at 2212 with an intensity greater than that of the emission band at 2125. This was first noticed in a few cadmium plates given me by H. G. Howell, of Armstrong College, Newcastle-on-Tyne. On trying

an arc myself, it was found that with exposures of the order of one or two seconds, the 2212 band appeared with marked intensity.

(2) With a high-frequency (valve) circuit and external electrodes applied to a tube containing cadmium vapour at pressures ranging from 10 mm. to 40 mm. or higher, the narrow isolated band at 2212 was not obtained. In agreement with Cram's results, it was found that the continuous emission on the short wave-length side of the resonance line 2288 extended as far as a sharp edge in the neighbourhood of 2212. In two or three spectrograms, however, an increased intensity near 2212 gave the appearance of a narrow band at that place.

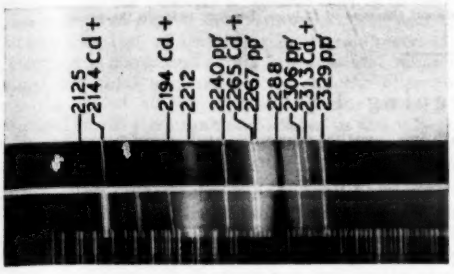

FIG. 1. Arc spectra of cadmium, with copper arc superimposed on the lower spectrum.

(3) In the case of zinc vapour excited with the same high-frequency arrangement, an emission band at 2000 was obtained without difficulty at pressures of the order of 10–12 mm., as is clearly shown in Fig. 2. This fact is not irrelevant to the origin of the 2212 cadmium band, because zinc and cadmium have corresponding absorption bands—at approximately 2064 and 2002 for zinc; 2212 and 2125 for cadmium. In a note in the *Physical Review*, Winans[3] has stated that the 2212 cadmium and the 2064 zinc bands, both present in absorption, are both *absent* in emission.

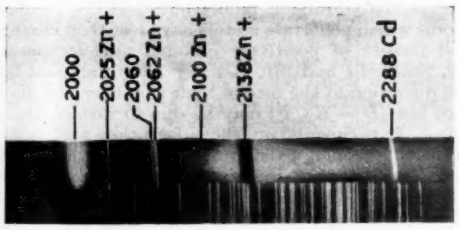

FIG. 2. Spectrum of zinc vapour when excited by high-frequency discharge, with external electrodes. Copper arc superimposed.

Although my observations as given in paragraph (2) might readily be used in support of Cram's view that the 2212 band is an impurity, it seems to me that the weight of the evidence is in favour of its being a true cadmium band. In support of this position, I submit the following arguments.

(*a*) The undoubted presence of 2212 as an emission band in the arc makes it less probable that its appearance, under certain conditions, in an excited tube, is due to an impurity. It is not without significance that in both the arc and the early electrodeless discharge showing this band, *pp'* lines are present with considerable intensity. These do not occur in Cram's spectra (nor in my recent high-frequency discharges), and it may be that the presence of a narrow band at 2212 is associated with the excitation of this group of lines.

(*b*) The undoubted presence of a band in both emission and absorption, in the related element zinc, strongly suggests the probability that the corresponding band in cadmium should also be present in emission, as well as in absorption.

(*c*) Since there is without question an absorption 2212 cadmium band, it is not a matter of surprise that there should be an emission band also. Of course, this does not necessarily follow, but the presence of an absorption band does help to make it less likely that an emission band, found in the same place, is due to an impurity.

The origin of certain diffuse bands which occur in the spectra of metallic vapours is, however, not always easy to settle. It is only through the co-operation and continued experiment of different workers, using different conditions, that certainty can finally be reached.

J. K. ROBERTSON.

Queen's University,
Kingston, Canada.
Dec. 11.

[1] Cram, *Phys. Rev.*, **46**, 205; 1934.
[2] Robertson, *Phil. Mag.*, **14**, 795; 1932.
[3] Winans, *Phys. Rev.*, **37**, 902; 1931.

Structure of Br III

THE spark spectrum of bromine, excited under different conditions, has been photographed over the wave-length range λ450–7000, using various instruments, and lines belonging to the doubly ionised atom have been identified.

These experiments have made possible the detection of the structure of Br III, which is found in all its characteristic features to be analogous to that of Se II, classified recently by us[1]. The intervals of the fundamental term $5s\ ^4P$ are 2587 and 2253 cm.$^{-1}$; and those of $5p\ ^4D$ are 2413, 2070 and 658 units. This scheme is, however, at variance with the one published by Deb[2], which, we consider, is improbable in many important respects. A complete report of the new classifications will be published shortly.

K. R. RAO.
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Jan. 16.

[1] *Proc. Roy. Soc.* (in press).
[2] *ibid.*, A, **127**, 204; 1930.

Large Sunspot Group of February 1935

ALTHOUGH the sunspot group referred to in NATURE of February 16 (p. 260) was not specially large, it was of interest because of its very rapid growth. Spectroheliograms in $K_{1,3,2}$ light were secured through thin cloud at the Solar Physics Observatory, Cambridge, on February 5, 6 and 7. On February 5 the group is shown on a plate exposed from $12^h\ 25^m\ 18^s$ to $12^h\ 26^m\ 51^s$, and as the formation was near the centre of the disc, it must have been recorded very near $12^h\ 26^m\ 5^s$. As no spot was shown on the Greenwich photograph

at 10h, this fixes the time of formation of the spot to within 2½ hours. On the spectroheliogram the feature was very small. On February 6 there is evidence of very rapid growth; preceding and following spots are clearly shown, and the group extended over about 10° of solar longitude. February 7 still further expansion was shown, with an extent of flocculus of about 15° longitude. Any other observations of this spot group on February 5 during the hours 10h to 12h 30m would be welcome as affording information of the details of development.

C. P. BUTLER.

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Feb. 16.

Plasticity of Rock Salt Crystals

THE plasticity of rock salt crystals when immersed in water has been the subject of much attention recently[1]. The fact that the effect takes place more easily in hot water suggests that the rate of solution of the surface is a factor. I have therefore tried bending small plates of rock salt under running cold water from a large tap, and have found that the plasticity is surprising. Under these conditions it is quite easy to make a right angle bend in a plate of rock salt more than a millimetre thick in a matter of seconds.

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[1] See E. G. Joffe, "Physics of Crystals", and *Proceedings International Congress of Physics, London*, 1934 (in the press).

Points from Foregoing Letters

HIGH-FREQUENCY radio waves such as are used in television (3–20 m. in length), can increase the temperature of certain solutions and of living tissues, and have been used in medical practice (diathermic treatment). Dr. Franz Nagelschmidt describes a method of directing and localising the heating effect by interposing dielectric substances (wax, ebonite) between the electrodes and object, and gives suggestions for practical applications.

Automatic recorders of water-level in deep wells register earthquake shocks. Prof. Perry Byerly and Mr. Francis B. Blanchard describe a water-level recording instrument, and compare its record of an earthquake with that obtained by the usual type of seismograph. They point out that both the primary tremors (*P*) due to compressional waves travelling through the earth's interior and the later undulations (*L*) due to compressional waves travelling along the earth's surface were recorded by the water instrument. The intermediate vibrations (*S*) travelling through the earth's interior and the Love waves were not recorded. This confirms the view that both these latter are shear waves and do not produce changes in volume, which alone affect the water-level.

By means of an improved Svedberg ultra-centrifuge rotating 120,000 times per minute and giving a force of 525,000 times that of gravity, Dr. Kai O. Pedersen has succeeded in bringing about changes in the concentration of solutions of substances of low molecular weight. From these concentration changes, deduced from the changes in optical refraction, the molecular weights have been calculated; they agree fairly well with the known values.

Prof. A. Szent-Györgyi in a succinct note states that in the main respiratory process of the muscle, the oxidisation of foodstuffs (or their loss of hydrogen) is brought about by oxidised products of succinic acid; these carry away the hydrogen in the presence of certain enzymes (dehydrogenases).

Mr. Clarence Cottam agrees with Dr. Kathleen Blackburn that the narrow-leaved form of the eel grass is not a hybrid but a different form of *Zostera marina*. From observations on the Atlantic coast from Maine to North Carolina, he concludes that the variation cannot be accounted for simply as due to the depth at which the plant grows, but that other factors such as the age of the plant, temperature, salinity, water currents and conditions of soil or rock bottom may affect the width of the leaves.

The conditions under which the spores of the onion mildew germinate are insufficiently known. Mr. R. McKay has kept the spores under observation for several years, and finds that at the end of three years about one per cent of the spores have their cell-wall sufficiently thinned for them to germinate in water in a warm room; the others are still good for another five years' resting stage.

Dr. Muriel E. Adair and Mr. G. L. Taylor have succeeded in obtaining for the first time microscopic crystals of the albumin from human serum (from dropsical patients).

Mr. M. Barak and Dr. D. W. G. Style have obtained diacetyl and its derivatives by means of chemical reactions which suggest that the acetyl radical, CH_3CO- is much more stable than usually assumed. They believe that this radical may possibly be an intermediate product in the photo-decomposition of acetaldehyde and acetone at room temperature, and in other important chemical reactions.

Prof. Tito Franzini points out that the hydrogen atoms which penetrate metals have lost their electrons and consist of positively charged nuclei (protons). Dr. Smithells and Mr. Ransley have indicated that the deviation in the rate of hydrogen from the square root law ($D = K\sqrt{P}$) may be due to surface adsorption. Experiments on the adsorption and rate of diffusion through palladium of ordinary and heavy hydrogen lead Prof. Franzini to assume an adsorption threshold on one side and an evaporation pressure on the other side of the metal.

S. W. Cram, not being able to confirm the observations of Prof. J. K. Robertson that cadmium vapour emits a band of ultra-violet light (wave-lengths around 2212 A.), when excited by an electrodeless discharge, has suggested that Robertson's observations may have been due to an impurity. Prof. Robertson repeated the experiment and obtained only traces of the band in certain spectrograms. He still believes, however, that cadmium emits such a band of light of wave-length 2212 A., and he submits spectrograms to show that it occurs in the arc spectrum of cadmium. Cadmium vapour absorbs light of this wave-length and it is probable therefore that it also emits it.

Research Items

Dual Organisation in Assam. A study of social organisation in Assam by Mr. J. K. Bose (*J. Dept. Letters, Calcutta University*, **25**) is based in part on a review of existing literature, in part on the results of field-work in the period 1931–34 among the Anals, the Aimols, the Lamgangs, the Mantaks, the Marrings and the Memis. It is thought that the dual organisation may throw light on the origin of the caste system. Among the Aimols, a very primitive tribe, there are two moieties, one superior and the other inferior, each having two phratries and each phratry two patrilineal clans; but the system is in process of disintegration owing to decreasing numbers and the scattered situation of the villages. Hence restriction in marriage is slackened; but in social and religious matters the dual organisation is strictly observed. Thus the social status of the superior moiety is recognised in all the important offices in the villages. The headman, assistant headman and priest all come from the superior moiety. The two moieties are also apart in the festivals they observe. The Anals, primitive hunter-agriculturists spread over sixteen villages in Manipur, have a typical dual organisation, while the Mantaks, a dwindling group, though in process of disintegration, retain a superior and an inferior moiety, but inferior officers are now drawn from the inferior moiety. The Lamgangs, a remote hill-people, show two moieties with only four clans each. Here there is evidence of the tendency to arrange the superior moiety in a hierarchy. Among the Marrings the dual organisation is of unique type, being based on territorial distribution. The Marring villages are grouped into a set of seven and a second set of five. This grouping has taken over the marital functions of the kinship groupings. It is clear that in Assam there are definite forms of dual or tripartite organisation of various types and in various stages of disintegration. Assam is, therefore, likely to prove as interesting for the study of early stages of society as Australia or Melanesia.

Reproduction in Nudibranchs. Mr. Leslie A. Chambers has made a valuable contribution to our knowledge of the methods of fertilisation and egg-laying in the Nudibranchiates (*Bull. Amer. Mus. Nat. Hist.*, **66**, 1934). The forms of the genital ducts are divided into four main types, and taking *Embletonia fuscata* as a typical nudibranch, the author describes the anatomy and histology of its reproductive system. There are three passages arising from the hermaphrodite duct—male, female and androgynous. A three-way valve effecting the selective separation of the spermatozoa from the ova is a feature hitherto undescribed, the author suggesting that it may have a possible general application to the hermaphrodite gastropods in which a separation occurs, that is to say, in most tectibranchs and all nudibranchs. There is also a mechanism for erecting the penis which seems to be peculiar to *Embletonia*. *Embletonia* was found in enormous numbers on the piles of a bridge near Beach Haven, N.J., all the individuals depositing spawn. In a few weeks they had all disappeared. This is typical of many nudibranchs, but as some species may be found breeding in the open sea as well as near the shore, it is suggested by the author that inshore spawning grounds are not essential, and that the large numbers of one species sometimes found spawning inland are due to the chance displacement and survival of a few individuals, and their rapid development, no migration taking place. Anatomical evidence is given that each individual may pass through repeated reproductive cycles in the same season. With so many broods and with every individual of each brood depositing numbers of spawn masses, each single mass containing several hundred ova, there is considerable possibility of deriving the presumed migrations from a single individual cast on the shore by chance.

***Calanus* Production in Norway.** Mr. Jacob D. Sømme has thoroughly investigated the biology of two species of *Calanus* (*finmarchicus* and *hyperboreus*) based on experimental studies and analyses of samples from the coast of Norway in various seasons (*Fiskeridirektoratets Skrifter. Serie Havundersøkelser*, **4**, 9; 1934). Both species winter in the Lofoten area at great depths. *C. hyperboreus* particularly is restricted in winter to the inner parts which are very deep, *C. finmarchicus* being not so sharply defined in its distribution. In spring a vertical migration takes place, and later both species are carried away over the coastal banks in the surface currents. The spawning area of *C. hyperboreus* is very restricted and mainly dependent upon the extent of the winter area of distribution, the development of the later stages probably depending on low temperatures. *C. finmarchicus* has a much longer period of spawning and a much larger spawning area. Both species may be found together. Tables for the identification of all stages are given, and it is shown that the larvæ of the two species are not distinguishable by morphological characters, but by measurement of the carapace rather than total length. Unfortunately, the paper by Dr. S. G. Gibbons on *Calanus finmarchicus* (Fisheries, Scotland, Sci. Invest., 1933. No. 1) was published too late for it to be used, as was also Dr. Nicholls's study of the life-history of *Euchaeta* (*Proc. Roy. Soc. Edinburgh*, 1934).

'Plaster Mould' Diseases of Mushroom Beds. A very useful article by Mr. W. M. Ware appears in the *Gardeners' Chronicle* of December 22 and 29, 1934. It describes two 'weed' fungi which are likely to grow on mushroom beds, to the detriment of the edible fungi. Both of the undesirable organisms are known as 'plaster moulds', since they produce a white, powdery covering similar to a dusting of plaster or lime. The white plaster mould (*Oospora fimicola* = *Monilia fimicola*) was known by English growers some time before it was recorded by the mycologist. It also occurs in France and the United States. Characters of the species are given in detail, and its occurrence described. It appears on beds just before they are ready for spawning, and also grows upon the covering of soil or 'casing', which is applied after the spawn has been added. Circumstantial evidence indicates that the fungus is introduced by the manure. The brown plaster mould (*Papulaspora byssina* or *Myriococcum præcox*) originally made its appearance in the United States in 1923, but has now appeared in Great Britain. This disease appears at the same time, and under similar conditions to the white plaster mould, but is not usually so harmful.

It first produces a white superficial mycelium, which quickly becomes cinnamon brown except at the edges. The brown part bears 'bulbils', or aggregations of hyphal cells, which seem to function as the sole reproductive bodies of the fungus. The brown plaster mould also seems to be introduced by the manure.

Traps of the Bladderworts. It is refreshing to find a genus of plants, the bladderworts (*Utricularia*), which scores so admirably off the animal kingdom. Prof. F. E. Lloyd (*Biol. Rev.*, **10**, 1, 72; 1935) gives an extremely interesting account of the various kinds of traps—really modified leaves—and especially of the entrance mechanisms. The swiftness of the action is remarkable. By making use of motion photomicrography speeded up to 160 frames per second, the whole action falls within the sequence of five frames, the opening phase falling between two frames and the slower closing phase occupying the rest of the time. The entrance mechanisms of the traps are shown to be far more complicated and more delicate in their adjustments than has heretofore been thought, and are shown to be purely mechanical in action.

Clean-up of Gases by Getters. The process of removal of gas by the action of electropositive metals such as magnesium and barium is of great technical interest since it is much used in the evacuation of vacuum devices. A. L. Reimann (*Phil. Mag.*, Dec. 1934) has investigated the process for the 'getters' magnesium, calcium and barium and a number of common gases. Some clean-up occurs when the 'getter' is first volatilised on to the walls of the vacuum vessel (dispersal gettering); there is then some absorption of gas by contact action and the rate of removal is accelerated by maintaining an electric discharge in the gas. The 'dispersal gettering' may be treated as 'contact gettering' by a series of freshly formed getter surfaces. The contact gettering is more effective with barium than with magnesium or calcium, and is greatest when a black deposit of finely divided barium was formed by dispersal in the presence of gas. In most cases of contact gettering, the getter can take up much more gas than would cover its surface with a monomolecular layer—the gas seems to diffuse into the interior of the deposit. The gettering is usually favoured by a rise in temperature. The gas absorbed by a getter may be liberated again by heating, by displacement by another gas, or by impinging electrons or ions. In one of the experiments on a valve, if the anode potential was applied before the filament was heated, the getter acquired a positive potential and the vacuum deteriorated by electron bombardment of the getter. If the filament was heated and anode potential then gradually increased, the floating getter deposit acquired a different, lower, stable potential and the vacuum began to improve by clean-up. In electric discharge gettering, the getter removes particles such as positive ions and metastable molecules, and in some cases these form chemical compounds which are more stable than the products of simple contact gettering.

Oxygen Isotopes in Meteorites. An investigation on the relative abundance of the oxygen isotopes O^{16} and O^{18} in stony meteorites (S. H. Manian, H. C. Urey and W. Bleakney, *J. Amer. Chem. Soc.*, **56**, 2601; 1934) by a method involving the conversion of the combined oxygen to water and then, by electrolysis, to oxygen gas, showed that the specific gravity of the water indicated, within an experimental error of 29 per cent, in the ratio $O^{18}:O^{16}$, the same isotopic composition of the oxygen from three stony meteorites (Mocs, Knyahinya, Homestead) as from terrestrial granite and from potassium chlorate. Relative abundances of the isotopes in the oxygen gases were investigated by the vacuum mass-spectrograph and the same results were found, the experimental error in $O^{18}:O^{16}$ being reduced to $\pm 2{\cdot}5$ per cent. The value $514 \pm 13{\cdot}1$ is submitted for the absolute abundance ratio $O^{16}:O^{18}$ for both terrestrial and meteoric oxygen. The agreement of this result with other mass-spectrographic determinations is compared, and the discrepancy with the band spectra value is pointed out. The average value of the mass-spectrographic determinations by the four different researches (omitting the results of Kallmann and Lasareff) is 517 ± 10.

The Methylene Radical. By the thermal decomposition of diazomethane carried in a current of ether or butane below 500°, the free methylene radical, $:CH_2$, appears. It removes mirrors of tellurium, selenium, antimony and arsenic from the tube. In the case of tellurium, a red solid polymer of telluroformaldehyde, $(HCHTe)_n$, is produced, whereas free methyl forms a volatile red liquid, dimethyl ditelluride, $CH_3TeTeCH_3$. F. O. Rice and A. L. Glasebrook, who report these results (*J. Amer. Chem. Soc.*, **56**, 2381; 1934), point out that they are not in agreement with current ideas on the nature of the methylene radical, most of which are based on Nef's premise that carbon compounds readily undergo a primary decomposition into a stable smaller molecule and a radical containing bivalent carbon, and some lines of evidence which would indicate that methylene should have a peculiar stability resembling that of a molecule rather than that of a free radical. At temperatures above 650°, it was found, but below the decomposition point of ether, only methyl groups were found; the methylene radical is apparently a highly reactive fragment of short life.

Meridian Observations of Faint Stars in Selected Areas. In the *Annalen van de Sterrewacht te Leiden*, **25**, 4, Dr. C. H. Hins publishes a general catalogue of positions and proper motions of 1190 standard stars in areas 2–115 of Kapteyn's plan of selected areas. This work is the reduction to a uniform system, and combination, of the work of five observatories taking part in Kapteyn's plan, namely, Leyden, Berlin Babelsberg, Bonn, Paris and Strasbourg. The positions are in every case modern meridian circle observations of right ascension and declination, and proper motions have been found by comparison with old observations: but it is found that the modern precision so much exceeds the old that better proper motions would be obtained by repeating the observations in a few years time than by combining new with old observations. The author has reduced all the observations to the Leyden system as fundamental. (This system is in full agreement in R.A., and in very close agreement in Dec., with the P.G.C. system.) The magnitudes of the stars lie for the most part between $7{\cdot}6^m$ and $9{\cdot}8^m$, the average magnitude being $8{\cdot}5^m$. The unit of weights is, on the average, $\pm 0{\cdot}0275^s \sec\delta$ and $\pm 0{\cdot}44''$ for R.A. and Dec. respectively, the weights attached to individual stars being for the most part from 2 to 10. Dr. Hins may be very heartily congratulated on the completion of this part of Kapteyn's plan of selected areas.

Effect of the Earth's Magnetic Field on Cosmic Rays in the Stratosphere

By MAX COSYNS, Physical Laboratory of the "Fondation Medicale Reine Elisabeth", Brussels.

DURING the last ascent of the balloon *F.N.R.S.* (August 18, 1934), we had the opportunity of measuring with precision the intensity of cosmic rays at altitudes of about 12,000 m., 15,000 m. and 16,000 m., by means of the ionisation chamber (Kolhörster type) which was used during our previous ascent with Prof. A. Piccard (August 18, 1932).

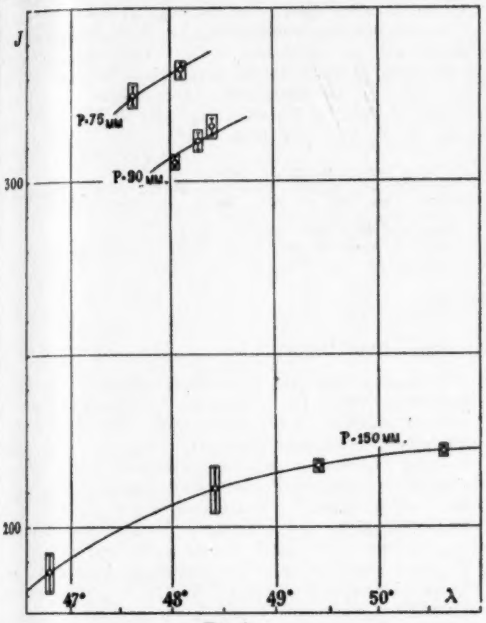

FIG. 1.

The comparison of these data, and also those of the previous ascent, shows clearly an effect of the earth's magnetic field.

From our sixty values of ionisation intensity (J), obtained at pressures of the atmosphere (P) ranging from 73 mm. to 170 mm. of mercury, and between 46° and 51° of north magnetic latitude (λ), we can deduce functions relating J to P, and J to λ (Figs. 1 and 2).

In Fig. 1, the circles give the mean values; the vertical lines give the probable error calculated from the dispersion of individual observations; the rectangles give the total probable error, calculated from the dispersion of individual readings, and from the precision of measurements of atmospheric pressure and geographical position. The atmospheric pressure was measured by means of two mercury barometers; the geographical position was determined by vertical photography with a Leica camera and infra-red films (precision = 30″) or by astronomical observations when the clouds below were too thick for photography (precision = 10′). The geomagnetic latitude was calculated taking 78° 30′ N. and 69° 8′ W. as the co-ordinates of the pole of the principal earth-magnetic doublet[1].

Through the four points of Fig. 1 which correspond to a pressure of 150 mm., we can draw a smooth curve; if we multiply the ordinates of that curve by reduction coefficients obtained from Fig. 2 (J vs. P), for pressures of 90 mm. and 75 mm., we obtain the two upper curves of Fig. 1, fitting the corresponding points within the probable error.

A comparison of these results with the theoretical curves of Lemaître and Vallarta[2] shows perfect agreement if we assume that more than 80 per cent of the ionisation in the stratosphere (for $\lambda > 50°$) is due to a charged corpuscular radiation of magnetic hardness $X_0 = 0{\cdot}30 \pm 0{\cdot}02$, and to the secondaries emitted by that radiation in the earth's atmosphere. Within the limit of experimental error, this is in perfect accordance with the results of Clay[3], who found $J = 12$ at $P = 150$ mm. and $\lambda = 18°$, and those of Clay and Compton[4], showing a maximum curvature of the (J vs. λ) curves for about $\lambda = 50°$, at pressures between 450 mm. and 760 mm.

The analysis of our (J vs. P) curve (at $\lambda = 48°$) (Fig. 2) by means of the Gross-Lenz method[5], gives a transformed curve $P\Psi_p = PJ_p - P^2 dJ_p/dP$, showing three maxima, corresponding to about 130 mm., 190 mm. and 400 mm. of mercury. Although their position is not defined with precision, the existence of the maxima seems to be beyond doubt, the amplitude of the corresponding variation of J being more than three times larger than the probable error.

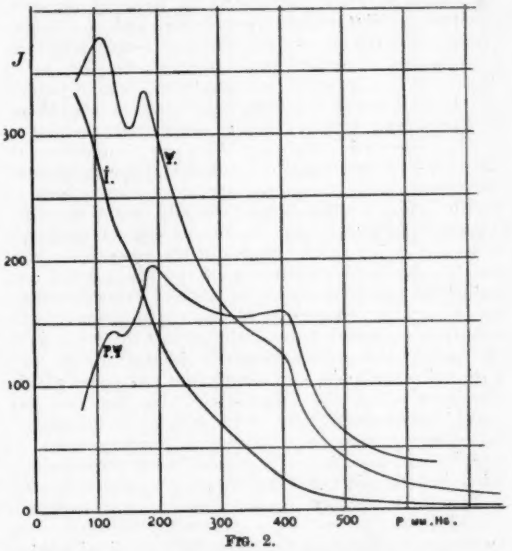

FIG. 2.

These three maxima show the existence of, at least, three soft components in the cosmic radiation, with ranges of the order of 130 mm., 190 mm. and 400 mm. of mercury. But, as the shape of the (J vs. λ) curve requires a very narrow range of magnetic hardness for the primary rays, only one of these components, if any, is a primary one.

To my idea, the hypothesis according best with the observed facts would admit a primary radiation consisting of two corpuscular components A and B, of respective magnetic hardness $X_{0A} = 0{\cdot}30$ and $X_{0B} = 0{\cdot}45$. The A component, positively charged, would give secondaries (electrons and positrons) of

discrete energy distribution, of which the hardest three components would have absorption coefficients of the order of 0·0018, 0·0039 and 0·0057 gm.$^{-1}$ cm.^{2}. The B component would give secondary radiations of the same nature as the secondaries issuing from A, with an energy distribution as yet unknown, but corresponding to an absorption coefficient of the order of 0·0027 gm.$^{-1}$ cm.^{2}.

The A and B components may perhaps be identified with Regener's components H_1 and H_2; their respective magnetic hardness X_β, calculated by the method proposed by Heisenberg[6], gives the right order of magnitude, if we assume that the primary rays are α-particles. If we suppose that $X_{\beta A}$ is exactly equal to 0·30, we find $X_{\beta B} = 0{\cdot}50$; this gives a good reproduction of Clay's curves (J vs. λ) at sea-level. However, Regener's values for the respective intensity of those components at the earth's surface are not in good agreement with our hypothesis. But it must be noted that the calculation of those intensities requires many assumptions about the secondary emission mechanism; it might be, therefore, that a new discussion of deep water measurements, with different assumptions, would give values more in accordance with magnetic effects.

Our hypothesis is also in quantitative agreement with the east-west asymmetry observed by H. Johnson and others. Quantitative divergences from those measurements may be attributed to the fact that we know little about the angular distribution of secondaries around the primary direction; and also to the fact that no account has been taken of the atmospheric electrical field effect. This effect is not negligible for the softer part of the radiation responsible for east-west asymmetry, as a calculation of a lower limit of the variation of the angle of incidence β of rays gives: $\Delta \tan\beta = \pm 515.E^{-1/2}$ (where E is the energy of the ray, in electron-volts).

A more detailed account of the experiments described above will be published soon. The measurements were made possible by the help of the Belgian "Fonds National de la Recherche Scientifique", with the advice of Prof. A. Piccard and with the very efficient help of N. Van der Elst.

[1] Bauer, *Terr. Mag.*, **28**, 1; 1923.
[2] Lemaître and Vallarta, *Phys. Rev.*, **43**, 87; 1933. Lemaître and Bouckart, *Ann. Soc. Sci. Brux.*, **54**, A, 162; 1934.
[3] Clay, *Physica*, **1**, 5, 376; 1933.
[4] Compton, *Phys. Rev.*, **43**, 387; 1933.
[5] Lenz, *Z. Phys.*, **83**, 194; 1933. Gross, *Z. Phys.*, **83**, 214; 1933.
[6] Heisenberg, *Ann. Phys.*, **13**, 430; 1932.

National Water Policy in Great Britain

THE recently issued report of the Joint Conference of the Institution of Water Engineers, the British Waterworks Association and the Water Companies Association on national water policy is a document of considerable interest, dealing, as it does, with a matter of vital public importance which has been debated for some time past in the Press, in Parliament and in various other quarters. It is to be regretted, however, that the Committee to which the question has been referred, appears to have been composed of representatives or consultants of water supply undertakings (mainly municipal) for domestic purposes, and, so far as can be gathered from a scrutiny of the names of the members, there was no direct representation of the commercial and industrial users of water, as also of other interests no less vitally concerned in the exploitation of the country's supplies. Land drainage and the prevention of floods, although necessarily bound up in any national water policy, evidently did not come within the purview of the Committee. Neither has any consideration been given to the aspects of the matter as affecting fisheries, navigation, canal sources of supply, and the like. The report is concerned solely with the allocation of water supplies to domestic uses.

The first matter dealt with is the proposed establishment of a 'water grid', put forward some time ago by Mr. Alan Chorlton, M.P., and advocated by him in a presidential address to the Institution of Mechanical Engineers in October 1933. This scheme, which is based on the analogy of the electricity grid, is condemned in the report in no uncertain terms. "We are definitely of opinion," states the Committee, "that as regards water supply, such a system is totally unjustifiable from every point of view, and especially in its economic aspect." The proposal is analysed in detail in a memorandum attached as an appendix to the report, summarising the objections under eight heads, which, for reasons of space, cannot be discussed here. Although, perhaps, controversial in some respects, they are weighty in substance and the cumulative effect is decidedly condemnatory. The Committee expresses itself as quite satisfied with the *status quo*. "In the unusual difficulties resulting from the recent exceptional drought, the water undertakers of this country have generally proved themselves well qualified to protect the true interests of their consumers and to meet their obligations to the public at large." Accordingly, the Committee is equally averse to the nationalisation of water supplies under a National Water Board. It considers the Ministry of Health to be the proper central water authority, and puts forward a proposal to meet the conditions at present prevailing by the "creation of a distinct, separate and specialised Water Department of the Ministry of Health", with various powers which are set out in detail.

It is perhaps not surprising that a Committee, constituted as stated above, should affirm its faith in the Ministry of Health as the sole suitable arbiter and dispenser of water throughout the country, but for the reasons already given, this can only be considered as a one-sided view. Other interests will scarcely be disposed to agree to such a monopoly. The British Association Research Committee on Inland Water Survey, whose investigations are referred to non-committedly, has been urging the establishment of a national survey of water supplies on a purely scientific basis under the Department of Scientific and Industrial Research. The Government, while acceding to the overwhelming demand for a survey, has seen fit to disregard this recommendation and to place the survey in the hands of the Ministry of Health. It is difficult to appreciate the grounds upon which this step has been taken, since no analogous example from the practice of other countries have been cited in support of it. That the Ministry of Health, the proper functions of which are clearly indicated in its designation, should intervene in other spheres where its action and control might be misguided and detrimental, is a matter greatly to be deprecated. BRYSSON CUNNINGHAM.

The Process of Coagulation in Smoke*

IN contradistinction to hydrosols, smokes are unstable systems. Their particles cohere when brought together by Brownian agitation, and this process of coagulation proceeds spontaneously until the system becomes a coarse suspension of complex aggregates, and finally sediments rapidly.

In recent years, special methods have been developed for counting the number of particles in many types of smoke, and the process of coagulation has been studied quantitatively in a variety of systems. It has been found experimentally that the decrease with time of the number of particles in a smoke is given to a first approximation by the expression $1/n - 1/n_0 = Kt$, where n is the number of particles present in a given volume at time t, n_0 the initial number and K a constant. As is well known, an expression of the same form is valid for the recombination of ions, but in a normal smoke the combination of particles to form aggregates is only influenced slightly, if at all, by electrical charges.

A comparison of the coagulation constants or K values for different smokes of about the same mass concentration shows that they vary between comparatively narrow limits from about $0{\cdot}8 \times 10^{-9}$ cm.^{3} sec.$^{-1}$ in the case of oxide smokes formed in the electric arc to $0{\cdot}50 \times 10^{-9}$ cm.^{3} sec.$^{-1}$ for a standard smoke of stearic acid of mass concentration of 15 mgm. per cubic metre.

The structure of the aggregates and the nature of the material do not, so far as is known at present, exert any marked effect on the rate of coagulation, which appears to be a purely physical process dependent on the chance encounter of particles in Brownian motion. Experimental evidence, however, shows that the coagulation constant increases rapidly when the average size of particle falls below 1×10^{-5} cm. radius, and it increases also with the degree of heterogeneity of the smoke. By a careful study of the conditions under which a smoke is formed, Patterson and Cawood have prepared disperse systems of stearic acid particles which initially approach to uniformity in size. This was accomplished by dispersing the heated solid in a rapid blast of hot air, and by this means diluting rapidly the concentrated smoke before coagulation had proceeded far. Such smokes are readily reproducible and form standard systems which coagulate at the same rate and contain the same number of particles, and since they form compact aggregates they approximate in character to ideal systems of spherical particles.

The well-known theory of von Smoluchowski, which has been confirmed experimentally for the coagulation of sols by the comprehensive researches of Tuorila, when modified so as to apply to aerial systems, enables the coagulation constant of a homogeneous smoke to be calculated from first principles. Patterson and Cawood have shown that when the experimental data for these 'blown smokes' are interpreted rightly, a remarkably close agreement between theory and experiment is obtained. Theory also indicates that whilst in sols undergoing quick coagulation the rate should be independent of size, in aerial systems it should increase as the particle size diminishes; a prediction in entire conformity with experiment.

Both in sols and aerosols, theory shows that heterogeneity must increase the chances of encounter between particles, but although in sols it has been possible to check experimentally the extension of von Smoluchowski's theory proposed by H. Müller, for heterogeneous smokes theory so far has not proved more than a qualitative guide.

The study then of smokes affords strong confirmatory evidence of the validity of Smoluchowski's theory, and lends support to the view that this continuous process so characteristic of these systems is akin to the quick coagulation of sols in the presence of electrolytes, and points to the probability that in both classes of system every collision between particles is effective. It must, however, be noted that the coagulation constants for systems of fine suspensions in water and in air are widely different, the latter being about a hundred times as great as the former. But since the time taken to reduce the original number of particles in a system to any given fraction depends on the number as well as on K, the disappearance of particles by coagulation in town fogs and other polluted atmospheres will be slow.

* Substance of the Liversidge Lecture delivered by Prof. R. Whytlaw-Gray, O.B.E., F.R.S., before the Chemical Society on February 14.

British Industries Fair, 1935

IN the account given last year in NATURE of the 1934 British Industries Fair, it was described as the largest national trade fair in the world. The 1935 Fair, which opened in London on February 18, is even larger than its immediate predecessor—a reflection, it may be hoped, of increasing prosperity in the nation's trade. At Olympia the lighter industries occupy every available square foot of exhibiting space, while the textile and furnishing sections at the White City are larger and more fully representative than ever. The main object of the Fair is, of course, a commercial one; the most welcome visitors are buyers. But the Fair has, undoubtedly, an educational value, for it presents to the visitor, in an attractive and accessible form and in a condensed space, a general survey of the results of the nation's manufacturing industry. Moreover, every changing phase in the tastes and habits of the people is reflected in such a collection of manufactured articles as is to be found at the Fair. The removal of much that is tedious and unnecessary from domestic work is indicated by the increased popularity of chromium-plated ware and of stainless steel and stainless silver articles, and by the space allotted in the Fair to the exhibition of devices for domestic mechanisation. The exhibition in larger quantities of open-air equipment of all kinds indicates that increasingly the leisure of the people is being used in healthy pursuits.

At Olympia, the exhibition is, as previously, divided into sections according to industries, and it is perhaps symbolic of the increasing recognition of the co-operation which must exist between science and industry, that the section devoted to the exhibition of the products of the Scientific and Optical

Instruments Group should occupy a prominent position near the main entrance to the Fair. The exhibits of the various firms in this section are placed so compactly together that a visual impression is conveyed of the co-operation and joint effort which is to be found among the members of the industry. The instruments shown are mostly optical in character, and one is reminded again of the large part played in scientific and industrial life by the products of the optical firms. Besides the normal instruments for laboratory equipment, special instruments are shown for use in aeronautics, astronomy and meteorology, together with those specially adapted to nautical and surveying requirements. One is impressed by the success which has been attained in so many of the instruments in combining the robustness required for industrial use with the necessary delicacy of movement.

Few things have been more striking of recent years than the development of long-distance telegraphy. It is but a short time ago that the first photographs were telegraphed from Australia to England, and quite recently a cinematograph film was exhibited in England showing events which had taken place but a few hours earlier in Australia. The exhibit of Cable and Wireless Ltd. is, on this account, of special interest. The modern system of long-distance telegraphy is admirably shown at its stand. The types of apparatus used for this work are presented in actual operation, and a study of the receiving and transmission units, magnifying relays, distortion removers and regenerators gives the visitor a clear idea of the inventive research which has enabled long-distance telegraphy to become part of his daily life. Realism is added to the demonstration by the fact that a written telegram, handed in at one end of the stand, is delivered as an automatically typed message at the other end after having passed through the complete system.

The chemical industry provides another example of the co-operation which may exist between firms in the same industry to their mutual benefit. Messrs. Hopkin and Williams and British Drug Houses Ltd. have combined their knowledge and experience to further the production of chemical reagents of an exceptionally high standard of purity, and these reagents are being exhibited by the firms. The very large field covered by the activities of Imperial Chemical Industries Ltd. is well illustrated by the fact that this firm has thought it worth while to devote a large portion of its space at the Fair, not to the display of its products, but to a presentation of its sales machinery. By means of interesting maps, the way in which chemical products enter into almost every phase of industry throughout Great Britain is clearly demonstrated. The same firm is making a special point of the hydrocyanic acid method of fumigation, especially for the cleansing of vermin-infested houses. Great success is claimed for this method of fumigation, and specimens of the fumigant and of its prospective victims are shown. The same fumigant has a variety of other and more pleasant uses, the removal of fruit-damaging insect pests from orange groves being specially emphasised as being of interest to overseas visitors.

Of the other industries represented at the Fair at Olympia, no section is more attractive, and certainly none more colourful, than that of the glass and pottery trades. A more perfect blending of utility and beauty can scarcely be imagined. It is perhaps fitting that the products of possibly the most ancient craft represented at the Fair should appear so near to perfection. The beauty of the exhibits is enhanced by the excellent lighting, and the stands furnish an example of the use of modern lighting effects to improve the display of goods. Quite near to the glass and pottery section, on the floor above, is a large area devoted to plastics, and it is not uninteresting to compare the products of this very modern industry with those of the very ancient one mentioned above. The increasing use which is being made of plastic materials is reflected in the very large increase of space occupied by the plastic group. In this industry the gap between laboratory experiment and workshop practice has been most effectively and rapidly bridged.

The fact that in London alone more than fifteen hundred firms are exhibiting almost every variety of manufactured articles makes it obviously impossible in a limited space adequately to describe such a Fair. In addition to these firms, one hundred and thirty-four inventors are displaying for the first time to the purchasing public the results of their ingenuity, which range from rubber contrivances for the prevention of housemaid's knee to a mechanical device for 'breaking-in' new pipes.

At the White City every phase of textile manufacture is represented; whilst the furniture section at the same place presents a wide field of interest to those concerned with the evolution and modern developments of furniture. The Fair remains open until March 1. The Engineering and Hardware Section opens in Birmingham on May 20.

University and Educational Intelligence

CAMBRIDGE.—At the Congregation of the Regent House a grace will be submitted appointing Prof. G. H. F. Nuttall, Magdalene College, emeritus professor of biology, Prof. E. D. Adrian, Trinity College, Prof. R. C. Punnett, Gonville and Caius College, Balfour professor of genetics and Mr. C. Forster-Cooper, Trinity Hall, University reader in vertebrate zoology, delegates from the University to the tercentenary of the National Museum of Natural History in Paris next June.

At Newnham College the Henry Sidgwick Memorial Lecture will be delivered on March 9 in the College Hall at 5 p.m. by Sir John Russell, director of the Rothamsted Experimental Station. The subject of the lecture is "The Impact of Science on the National Life".

THE thirteenth Unity History School will be held in Rome on April 15–22. The subject of the meeting will be "Science in the Modern World". On April 15, the inaugural lecture entitled "Science and Philosophy" will be delivered by Prof. F. Enriques, president of the School of the History of Science, University of Rome. Other lectures will be delivered by Mr. F. S. Marvin, director of the Unity History Schools, Prof. H. Dingle, Dr. W. A. Parr, Prof. E. Radl, Dr. C. H. Desch, Prof. C. Formichi, Dr. G. Sarton, and M. Lheritier. Several discussions have also been arranged. Further information can be obtained from Mrs. K. E. Innes, 29 High Oaks Road, Welwyn Garden City, Herts.

VOCATIONAL guidance service finds a valuable auxiliary in the *Journal of Careers* (monthly, 1s.). The December issue contains "The Prospect in

Surgery" by Sir Holburt Waring, a sequel to an article in the preceding month by Sir Humphry Rolleston on general medical practice and the main branches of specialisation. Sir Holburt gives expression to a view which, he says, will be considered in many quarters as revolutionary, namely, that the methods which are beginning to be practised in industry—selection on account of special aptitude, mentality and physical characteristics, might well be applied in surgery and also in the various branches of medicine. Considerable space is devoted to civil aviation: in addition to the first of a series of articles on the opportunities of new careers which the development of flying will offer, there is a summary of an address by Prof. Sutton Pippard to the Royal Aeronautical Society on the training of an aeronautical engineer. Veterinary surgery as a profession for women is discussed by Beatrice Lock, this being the second of a series of articles on "Women in the Professions". Another useful series deals with the prospect for public school and secondary schoolboys in the iron and steel industry, the article in the December issue being on technical and commercial posts. Lieut.-Col. Levey, managing director of the West African Information Bureau, writes on the prospects for British commerce in West Africa. The *Journal* has not failed to direct attention to the complaint, voiced in the presidential address to the Association of Special Libraries and Information Bureaux by Sir Richard Gregory, of the inadequacy of the arrangements made for the treatment of scientific news in daily and weekly newspapers. New fields of work should be opened up for science graduates with journalistic ability.

Science News a Century Ago

Telford and the Institution of Civil Engineers

At a special meeting of the council of the Institution of Civil Engineers held on February 23, 1835, the following extract from the will of Telford was read: "To the president for the time being of the Civil Engineer Institution in trust, the interest to be expended in annual premiums under the direction of the Council, 2,000£."

"All my scientific books, book cases, prints and such drawings, as my executors shall consider suitable, are to be delivered to the Civil Engineer Institution for its use and benefit, on condition, that all those articles, as well as the books, prints and drawings, shall, in case of the said Institution being discontinued, be delivered to the Royal Society, Edinburgh, for its use."

The council resolved that the premiums should be both of an honorary and pecuniary nature, and that the honorary premiums should consist of gold, silver and bronze medals, and that in the distribution of premiums no distinction should be made between natives and foreigners.

The Zoological Society

On February 24, 1835, Owen read a paper to the Zoological Society entitled "Description of a Microscopic *Entozoon* infesting the Muscles of the Human Body". He said that upwards of fifteen different kinds of internal parasites were already known to infest the human body, but none had been found of so minute a size, or existing in such astonishing numbers, as the species he described. The muscles of bodies dissected at St. Bartholomew's Hospital had been more than once noticed by Mr. Wormald, the demonstrator of anatomy, to be beset with minute white specks; and this appearance having again been remarked in the body of an Italian, aged forty-five years, by Mr. Paget, a student at the hospital, who suspected it to be produced by minute Entozoa, the suspicion was found to be correct, and Owen had been furnished with portions of the muscles for examination. An account of his observations was published in the *Philosophical Magazine* of June 1835.

University of London

The annual general meeting of the proprietors of the University of London was held on February 25, 1835. The report expressed satisfaction at the prospects of the institution, and stated that the number of students in the Faculty of the Arts and Law during the year had increased from 122 to 137, the number of students in Medicine from 347 to 371. The number of pupils in the junior school had increased from 284 to 303. The total receipts for 1833 had been £9,890 3*s*. 0*d*. and for 1834 £9,971 16*s*. 8*d*.

The Natural History of Wasps

A paper on the natural history of wasps was read on February 27, 1835, by the Rev. E. T. Bigge, of Merton College, to the Ashmolean Society of Oxford. The object of the paper, said the author, was to correct the mistakes into which several writers had fallen, and to state the results of his own observation on two species, *Vespa vulgaris* and *Vespa Britannica*. The former, he said, was common in all parts of the kingdom; the latter, though occasionally met with in the southern counties of England, was abundant in the northern districts, and in Scotland, as well as in the northern parts of Europe. Having directed attention to the points of difference in the two species, the author went on to state some interesting facts relating to both species. Societies of wasps, as of bees, consist of three different classes of inhabitants, males, females and neuters. The neuters, or imperfectly developed females, are the common wasps which infest our houses and gardens, and form the majority of the colony. The author had never seen a nest of either species in which he had not observed, after 9 o'clock, in the summer months, a sentinel watching the entrance to the nest. A ground nest has two apertures, one for entry and one for exit. It is curious that if one stops up a wasps' nest, the returning wasps will not sting the aggressor, while those which escape from the inside will attack him instantly.

Weather in the United States

In the *Mechanics' Magazine* of February 28, 1835, it was stated that: "The winter in America has been one of almost unprecedented severity. In January the thermometer sunk at New York to 5° below zero—at Baltimore to 10°—at Washington to 16°—at Albany to 32°—at Montreal to 35° and at New Lebanon in Columbia county to below 40°, the mercury in the bulb being 'congealed and for some time immovable'. The harbours of Portland, Newburyport, Boston, New Bedford, New Haven, Philadelphia and Baltimore have all been frozen over; some of them hard enough to bear carriages."

Societies and Academies

LONDON

Royal Society, February 14. G. BARRY, J. W. COOK, G. A. D. HASLEWOOD, C. L. HEWETT, I. HIEGER and E. L. KENNAWAY: The production of cancer by pure hydrocarbons (3). Tests for cancer-producing activity on the skin of mice have been carried out with a number of pure compounds of known molecular structure, most of which have been polycyclic aromatic hydrocarbons. In all, some 140 different compounds have now been tested. Of these, 69 are related to 1 : 2-benzanthracene and 25 of them have given positive results. 1 : 2-benzanthracene itself has very little carcinogenic activity, but such activity is shown by derivatives in which substituents (saturated alkyl groups or additional rings) are attached to positions 5 or 6, or both. The most active so far encountered is methylcholanthrene, a hydrocarbon which was obtained by simple chemical means from the deoxycholic acid of bile. In this way a direct relationship has been established between the carcinogenic compounds and some normal constituents of the body. Of 71 compounds not related to 1 : 2-benzanthracene, 65 have given completely negative results. Of the 6 compounds which gave positive results, only 3 : 4-benzphenanthrene ahd considerable activity. The remaining 5 compounds gave only 10 tumours (2 epitheliomas and 8 papillomas) in 360 mice. By way of contrast the 25 carcinogenic compounds *related* to 1 : 2-benzanthracene gave 437 tumours (335 epitheliomas and 102 papillomas) in 1,220 mice. C. H. WADDINGTON, J. NEEDHAM, W. W. NOWINSKI and R. LEMBERG: Studies on the nature of the amphibian organisation centre. (1) Chemical properties of the evocator. An evocator, that is, a substance capable of causing the ectoderm of the amphibian gastrula (*Triton* spp., axolotl) to differentiate into neural tissue, has been obtained in ether extracts of whole newt bodies and of mammalian liver. The active substance is present in the unsaponifiable fraction, and in the part of that fraction precipitable with digitonin. It comes out with the cholesterol if the unsaponifiable fraction is allowed to crystallise from alcohol in the cold, and is probably of a sterol-like nature. An active ether-soluble substance, which is also precipitable with digitonin, has been isolated from crude preparations of glycogen. The whole of the evocating activity of glycogen may be due to the admixture of this substance. C. H. WADDINGTON and D. M. NEEDHAM: Studies on the nature of the amphibian organisation centre. (2) Induction by synthetic sterol-like substances. Certain synthetic hydrocarbons have been implanted into young amphibian gastrulæ. Inductions of neural tissue have been performed by 1 : 9-dimethylphenanthrene, 9 : 10-dihydroxy-9 : 10-di-*n*-butyl-9 : 10-dihydro-1 : 2 : 5 : 6-dibenzanthracene, and 1 : 2 : 5 : 6-dibenzanthracene. The first two of these are œstrogenic and the third carcinogenic. There is therefore probably a group of evocating substances which overlaps with the group of œstrogenic and carcinogenic substances. This provides the first satisfactory evidence that more than one substance is capable of evocating, and suggests that the naturally occurring evocator is a sterol-like substance.

EDINBURGH

Royal Society, February 4. W. L. BRAGG: The new crystallography (Bruce-Preller Lecture). The mapping of atomic arrangement by X-ray analysis, first applied only to crystalline solids but more recently extended to glasses, liquids and gases, has now been pursued for more than twenty years. A review of the influence which this new knowledge has had in many branches of science is impressive. Some idea of this influence can be gained by taking examples in inorganic chemistry, organic chemistry, mineralogy, metallurgy and biochemistry. Though such isolated examples are only random soundings over a wide area, they serve to give an impression of the precision, simplicity and novelty of outlook which a knowledge of the actual atomic arrangement introduces. They also indicate the fascinating lines of research which are opening out ahead.

PARIS

Academy of Sciences, January 7 (*C.R.*, **200**, 101–176). EMILE BOREL: An elementary demonstration of formulæ on the distribution of prime numbers. V. ROMANOVSKY: A formula of A. R. Crathorne relating to moments. ALEXANDRE WEINSTEIN: The stability of plates with fixed edges. PIERRE MASSÉ: A partial differential equation of the theory of intumescence. GÉRARD PETIAU: The wave equation in a relative movement. NICOLAS KRYLOFF and NICOLAS BOGOLIUBOFF: Study of the case of resonance in problems of non-linear mechanics. LÉON CAPDECOMME: The use of a buffer accumulator for stabilising the current supply of an incandescent filament. The accumulator is placed in parallel with the filament on the main circuit: its automatic regulation is shown to be at least as good as any other automatic regulators in use and has the advantage of simplicity. NÉDA MARINESCO: An ultra-micrometer with stabilised valve. CONSTANTIN SALCEANU and DUMITRU GHEORGHIU: The magnetic susceptibility of organic liquids. Applications to the law of additivity. Using an improved method of measuring, giving an accuracy of the order of 1 per cent, the authors cannot confirm divergencies found by other workers from the additivity law. MARIO REGGIANI: The influence of electrolytes on the formation and stability of the metallic colloids obtained by ultra-sonic waves. In the preparation of colloidal mercury by means of ultra-sonic waves, the velocity of formation, the stability and diameter of the particles are all susceptible to a very slight chemical modification of the dispersing phase. The effect of traces of albuminoids (less than 0·1 per cent) is very marked in this respect. JEAN COURNOT and GEORGES MEKER: The cementation of copper by aluminium. ANDRÉ GIRARD and GEORGES CHAUDRON: The constitution of rust. Experiments on the cause of production of the magnetic oxide of iron by metallic iron in the presence of rust. HENRI GUÉRIN: The reduction of the arsenates of the alkaline earths by carbon. Barium arsenate. A detailed study of the products given by a mixture of barium arsenate and carbon heated in a vacuum at temperatures between 500° C. and 1,200° C. PIERRE DUBOIS and EDOUARD RENCKER: The dilatometric study of the dehydration and thermal decomposition of some manganese compounds. ANDRÉ MORETTE: The reduction of the vanadium oxides by carbon monoxide and by carbon. XAVIER THIESSE: The preparation and properties of sodium ferrate (hypoferrite). A solution of ferrous sulphate dropped into a boiling concentrated caustic soda solution gives a green solution of hypoferrite containing up to 20 gm. of $Fe(OH)_2$ per litre. The solid salt is precipitated on

cooling. The alkaline solution does not appear to be oxidised by air. JEAN AMIEL: The preparation and properties of some cupritetrachlorides and cupritetrabromides. JOSEPH BIECHLER: Researches on the dicyanimides. Sodium amide and cyanogen bromide react, under conditions specified, giving a good yield of sodium dicyanimide. MARCEL MATHIEU: The structure of the dinitrocelluloses. Results of an X-ray study. MARCEL ROUBAULT: The origin of the crystalline schists of Kabylie de Collo (Department of Constantine, Algeria). MLLE. J. ROESS: Study of the elasticity of rocks by the method of restitution. The application of photography to the falling ball method of measuring elasticity. BORIS CHOUBERT: The ancient strata of Gabon. FRANCE EHRMANN and JACQUES FLANDRIN: Concerning the large Lepidocyclines of the Eocene of Beni-Afeur (south of Taher, Departement of Constantine). PAUL FALLOT and GONZAGUE DUBAR: The presence of Lias containing Rhynchonellina in the Spanish Rif. ALBERT F. DE LAPPARENT: The nummulitic transgression in the Provence Alps. DANIEL SCHNEEGANS: The discovery of strata with *Cardita Beaumonti* at Gabon (French Equatorial Africa). JACQUES DE LAPPARENT: The structure of the mountains and the tectonic position of the bauxites on the slopes of Parnassus (Greece). ADOLPHE LEPAPE: The origin of the helium of natural gases. The relation between the richness in helium and of lithium in certain saline hydro-mineral springs. EM. DE MARTONNE and MME. FAYOL: A formula for the aridity index. JOSEPH BLAYAC and MLLE. MARIE CHAUBET: Palæontological discovery in the Llandeilo sub-stage of the Ordovician of the Montagne-Noire. PIERRE DOPTER and MLLE. THÉRÈSE FRÉMONT: The absorption of nitric nitrogen and of ammoniacal nitrogen by the higher plants. MLADEN PAIC and MARCEL PHILIPPE: A pigment elaborated by the diphtheria bacillus. Some pigment is absorbed from the culture broth by collodion, but the toxicity of the culture is not reduced. ALEXANDRE BESREDKA and LUDWIG GROSS: The importance of the point of inoculation in the evolution of the Ehrlich sarcoma.

LENINGRAD

Academy of Sciences (*C.R.*, **4**, No. 3). A. SVETLOV and V. STROGANOV: Solution of a magnetic problem in two dimensions. A. ARSENJEVA: Photo-electric transmission in crystals of silver chloride. G. KRUTKOV: Linear problems of the theory of Brownian movement (3). A. LEVASHOV: A contribution to the theory of gravitation. V. FESENKOV and E. PIASKOVSKAJA: Brightness of the day-time sky and the scattering of light in the atmosphere. A. BALANDIN, J. EIDUS and N. ZALOGIN: Formation of butadeine and acetylene from ethylene by the high-frequency discharge. V. SADIKOV and V. MENSHIKOVA: Action of the animal proteolytic enzymes on the vegetable proteins. The proteins in seeds are not affected by pepsin and pancreatin. G. LEVITSKY: New fixing solutions revealing the morphology of chromosomes. E. HASRATIAN: Physiology of irradiation and concentration of processes in the cortex of the cerebral hemispheres. I. VASILJEV: Vernalisation of winter varieties and frost resistance. The process of vernalisation lowers the frost resistance of winter varieties. V. KARASIK and M. LICHATCHOV: Relation between the chemical nature and the biological activity of the dihydroxide of methylphenarsazine and of its derivatives. G. FLEROV: Some geographical and historical variations in the Eurasian Ungulates. J. SCHAXEL: Determination of the regeneration of extremities in axolotl (1). O. ZVIAGINZEV: A new mineral containing metals of the platinum group. B. LICHAREV: The problem of the age of the Safet-Daron chalk in Darvas.

(*C.R.*, **4**, No. 4). I. VINOGRADOV: Some theorems of the analytical theory of numbers. N. KOSHLJAKOV: A general summation formula and its applications. L. KELDYSH: Measurable functions. B. A. ALEXANDROV: Quantum conditions and the Schrödinger equation. I. KURCHATOV: Artificial radioactivity and Landé's scheme. N. ZELINSKIJ, B. MICHAILOV and G. ARBUZOV: Thermal dissociation of the carbohydrates of the cyclohexane series. J. RYSS and R. URICKAJA: Dissociation of magnesium chromate. V. SADIKOV, V. ROZANOVA and G. NOVOSELOVA: Autoclave splitting of blood albumin by means of a 2 per cent potassium carbonate solution. G. LEVITSKIJ: Fixation changes of the chromosome body. S. KRAJEVOY: Trisomics and heterochromosomes in *Scorzonera nervosa*, Trevir. N. SHAPIRO and R. SEREBROVSKAJA: Relative mutability of the *X*- and the second chromosomes of *Drosophila melanogaster*. The mutation frequencies of the *X*- and the second chromosomes are proportional to the lengths of the genetically active parts of these chromosomes. R. BERG: Relative mutation frequencies on *Drosophila* chromosomes. O. TCHERNOVA: A new, widely distributed genus of may-flies from the northern regions of the U.S.S.R. J. SCHAXEL: Determination of regeneration in the extremities of axolotl (2). Transplantation of regeneration stages.

VIENNA

Academy of Sciences, December 6. HERBERT HABERLANDT and KARL PRZIBRAM: A labile coloration of fluorite. A number of specimens of greenish or bluish fluorite develop, either in the natural state or after irradiation with radium, a violet colour when exposed to ultra-violet light at the temperature of liquid air. This coloration, which soon fades when the mineral resumes the ordinary temperature, is probably related to the excitation of Lenard's short-lived centres. RICHARD GROSSMANN: Measurement of strong polonium preparations by ionisation in pure nitrogen. By ionisation of nitrogen of such high purity that the negative carriers are free electrons, the activity of polonium preparations showing ionisation currents up to 42,000 electrostatic units may be measured. KARL STRUBECKER: Lie's representations of the line elements of the plane on points of space. ARTHUR WAGNER: Critical remarks on the daily course of cosmic ultra-radiation from records taken on the Hafelekar (2,300 m.). Observations made from September 1931 until December 1933 are analysed and discussed, various sources of error being indicated. RUDOLF WAGNER: Methodical specification of pentameric pre-floration.

December 13. ELISABETH MATZNER: Atomic disintegration by neutrons. The elements carbon, aluminium, sulphur, iron, cobalt, nickel, copper, zinc, gallium, molybdenum, silver, cadmium, tin, platinum and lead have been investigated, as regards atom disintegration by beryllium neutrons excited by polonium, by two different methods, which give

concordant results. The greatest effects were found with carbon and nickel, and the smallest with lead and tin. HERBERT HABERLANDT: Investigations on the luminescence of fluorites and other minerals. Various new fluorites showing a natural red radio-photofluorescence are recorded, two of them showing the presence of radioactive inclusions. In certain fluorites with a yellowish-white photofluorescence, the active impurities are bituminous in character. JOSEF SCHINTLMEISTER and GEORG STETTER: Investigation of the disintegration of the light elements with the double-tube electrometer. All the light elements as far as chlorine have been examined. The fall in the disintegration is approximately exponential from the maximum for nitrogen, with a periodic function superimposed, the values for the odd elements being always greater than those for the even ones. A. SKRABAL: Reaction cycles. Reaction cycles are based on a reaction scheme which may be decomposed into two or more separate schemes with the same total reaction. These reactions occur far more frequently in chemical kinetics than is generally supposed, and include all reactions which proceed along two or more paths. OTTO AMPFERER: Tectonic studies in the Rhine valley.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Sunday, February 24

BRITISH MUSEUM (NATURAL HISTORY), at 3 and 4.30.—M. A. Phillips: "Fossil Mammals".*

Monday, February 25

BRITISH MUSEUM (NATURAL HISTORY), at 11.30.—G. Seccombe Hett: "Bats".*

ROYAL GEOGRAPHICAL SOCIETY, at 5.30.—Sir Norman Watson: "In the Coast Range of British Columbia". (Film.)

ROYAL SOCIETY OF ARTS, at 8.—D. R. Wilson: "Factory Accidents". (Shaw Lecture. Succeeding lectures on March 4 and 11.)

Tuesday, February 26

UNIVERSITY COLLEGE, LONDON, at 5.30.—Prof. J. R. Mathews: "The Northern Element in the British Flora" (succeeding lectures on February 27 and 28).*

ROYAL SOCIETY OF ARTS, at 4.30.—L. A. Jordan: "Empire Production of Tung Oil".

Wednesday, February 27

UNIVERSITY COLLEGE, LONDON, at 5.30.—I. C. Gröndahl: "Norwegian Students' Life in the Nineteenth Century" (succeeding lecture on March 6).*

Thursday, February 28

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Dr. R. A. Sampson: "Astronomical Time".*

THE CHEMICAL SOCIETY, at 8—(at the Royal Institution, Albemarle Street, W.1).—Dr. A. S. Russell: The Madame Curie Memorial Lecture.*

Friday, March 1

GEOLOGISTS' ASSOCIATION, at 7.30.—(at University College, Gower Street, W.C.1).—Annual General Meeting.

Sir Albert E. Kitson: "Outlines of the Geology of the Gold Coast, British West Africa".

ROYAL INSTITUTION, at 9.—A. Bryant: "Samuel Pepys: known and unknown".

Official Publications Received

GREAT BRITAIN AND IRELAND

The Institute of British Geographers. Publications Nos. 1 and 2: Transactions; and The Pastoral Industries of New Zealand, by R. Ogilvie Buchanan. Pp. xv+99. (London: George Philip and Son, Ltd.; Liverpool: Philip, Son and Nephew, Ltd.) 7*s.* 6*d.*

The Registrar-General's Statistical Review of England and Wales for the Year 1933. (New Annual Series, No. 13.) Tables, Part 2: Civil. Pp. iv+130. (London: H.M. Stationery Office.) 2*s.* net.

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1608 (A. 160): Abstract—Constitution of Magnesium-Rich Alloys of Magnesium and Nickel. By J. L. Haughton and R. J. M. Payne. Pp. 2. (London: H.M. Stationery Office.) 2*d.* net.

The University of London Animal Welfare Society. Eighth Annual Report, 1st July 1933 to 30th September 1934. Pp. 16. (London.)

Scientific Horticulture (formerly the H.E.A. Year Book). Vol. 3. 1935. Pp. 228+xliv. (Wye: Horticultural Education Association.) 3*s.* 6*d.* net.

The Carnegie Trust for the Universities of Scotland. Thirty-third Annual Report (for the Year 1933–34) submitted by the Executive Committee to the Trustees on 6th February 1935. Pp. iv+92. (Edinburgh.)

Congrès International des Sciences anthropologiques et ethnologiques. Compte-rendu de la première Session, Londres 1934. Pp. xxxii+340. (London: Royal Anthropological Institute.) 25*s.*

British Chemicals and their Manufacturers: the Official Directory of the Association of British Chemical Manufacturers (Incorporated). Pp. 459. (London: Association of British Chemical Manufacturers.) Gratis.

London School of Hygiene and Tropical Medicine. Classified Catalogue of Books in the Library, including Departmental Libraries. Part 2: Classes C and D; Theory and Practice of Medicine and History of Medicine. Pp. ii+31–51. (London.) Gratis.

OTHER COUNTRIES

Cornell University: Agricultural Experiment Station. Bulletin 610: A Study of Practices in Feeding Infants; Results of a Survey of 657 Babies in Villages of New York State, 1930. By Rachael Sanders Bizal. Pp. 34. Bulletin 613: An Economic Study of Land Utilization in Montgomery County, 1932. By F. F. Hill and George T. Blanch. Pp. 50. Bulletin 614: Rural Social and Economic Areas in Central New York. Pp. 100. Bulletin 615: Clothing Purchased by Farm Families in Tompkins County, New York, 1927–28. By Beulah Blackmore. Pp. 44. Bulletin 616: Study of Artificial Incubation of Game Birds, 1: Temperature Requirements for Pheasant and Quail Eggs; 2: Humidity Requirements for Pheasant and Quail Eggs. By Alexis L. Romanoff. Pp. 39. Memoir 169: A Physiological Study of Dormancy in Tilia Seed. By J. Nelson Spaeth. Pp. 78+4 plates. (Ithaca, N.Y.)

Smithsonian Miscellaneous Collections. Vol. 91, No. 17: Reports on the Collections obtained by the First Johnson-Smithsonian Deep-Sea Expedition to the Puerto Rican Deep—New Sponges from the Puerto Rican Deep. By M. W. de Laubenfels. (Publication 3283.) Pp. 28. Vol. 93, No. 1: The Effect of Ultraviolet Radiation on the Ova of the Ascarid Roundworms *Toxocara canis* and *Toxascaris leonina*. By W. H. Wright and E. D. McAlister. (Publication 3291.) Pp. 13. (Washington, D.C.: Smithsonian Institution.)

Colony and Protectorate of Nigeria. Annual Report on the Geological Survey Department for the Year 1933. Pp. ii+52+8 plates. (Lagos: C.M.S. Bookshop; London: Crown Agents for the Colonies.) 4*s.* net.

University of Michigan: School of Forestry and Conservation. Bulletin No. 5: The Hungarian Partridge in the Great Lakes Region. By Ralph E. Yeatter. Pp. 92. (Ann Arbor: University of Michigan Press.) 35 cents.

Palæontologia Sinica. Series C, Vol. 8, Fascicle 1: On the Carnivora from Locality 1 of Choukoutien. By Pei Wen-Chung. Pp. 222+24 plates. Series C, Vol. 8, Fascicle 3: On the Insectivora, Chiroptera, Rodentia and Primates other than Sinanthropus from Locality 1 at Choukoutien. By Chung-Chien Young. Pp. 166+10 plates. Series C, Vol. 10, Fascicle 1: On the Fossil Pisces, Amphibia and Reptilia from Choukoutien, Localities 1 and 3. By M. N. Bien. Pp. 36+3 plates. (Peiping: Geological Survey of China; The French Bookstore; London: Edward Goldston, Ltd.)

Trinidad and Tobago. Report on an Investigation into the Uses and Marketing of Forest Products in Trinidad and Tobago. (Council Paper No. 100 of 1934.) Pp. 85. 2*s.* 6*d.* Forestry Pamphlet No. 1: What Forestry in Trinidad Means. Pp. 12+2 plates. 6*d.* Forestry Pamphlet No. 2: The Forest Types of Trinidad and their Principal Species. Pp. 16+2 plates. 6*d.* (Trinidad: Government Printing Office.)

Union of South Africa: Department of Agriculture. Science Bulletin No. 137 (Division of Chemistry, Series No. 134): Influence of Fertilizers on the Nitrogen and Carbon Cycles in Soils; Experiments carried out on the Red Loam of the Zebediela Area, Northern Transvaal. By Dr. P. Kamerman and H. Klintworth. Pp. 20. (Pretoria: Government Printer.) 3*d.*

Biological Movie Booklets. Vol. 1: Normal Cell Division. By Clyde E. Keeler. Pp. 46. Vol. 2: Maturation of Sperm. By Clyde E. Keeler. Pp. 94. Vol. 6: Fertilization. By Clyde E. Keeler. Pp. 65. (Washington, D.C.: American Genetic Association.) 3 vols., 1.50 dollars.

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